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THE  
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A MONOGRAPH  
OF THE  
POST-TERTIARY ENTOMOSTRACA  
OF  
SCOTLAND  
INCLUDING SPECIES FROM  
ENGLAND AND IRELAND.



BY  
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## EXPLANATION OF PLATES I—XVI.





A MONOGRAPH  
OF THE  
POST-TERTIARY  
ENTOMOSTRACA OF SCOTLAND  
(INCLUDING SPECIES FROM ENGLAND AND IRELAND).

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INTRODUCTION.

THE larger part of the Ostracoda, described in the following Monograph, occur in the Glacial and Post-glacial beds of Scotland, and their geological position is a matter of very considerable importance. A mere catalogue of species under the vague general title of "Post-tertiary" would have little or no geological value. The numerous deposits, which such a term as "Post-tertiary" includes, are widely separated from each other, both in age and in the climatic conditions they represent. A vast series of clays, sands, and gravels were deposited during the epoch intervening between the commencement and cessation of more vigorous conditions of climate than are now prevalent in Great Britain; while that cessation itself was certainly gradual and may possibly prove to have been accompanied by its own recurring periods of increased heat and returning cold. It would be foreign to the purpose of this Monograph to discuss any theoretical explanations of the phenomena of the Glacial Epoch; but we shall endeavour to indicate the precise characters of the various beds containing the species of Ostracoda we describe. Whatever position in the great sequence of deposits any bed we have examined may ultimately be pronounced to occupy, we trust that its identification with our description may be sufficiently easy to permit the facts we have ascertained concerning its composition and fauna to be of service to future students.

This task is not without its difficulty, since many different writers upon the Glacial Epoch have employed the same terms, without meaning the same things. Three terms we shall at once discard. The term *Northern Drift* is far too loose to afford any help in the identification of the position of a bed; while one of the peculiar characteristics of the clay of the Clyde district, in which the fauna of the epoch is most perfectly preserved, is that it is in no sense whatever a drift, but one of the most gradually and quietly formed of deposits. The term *Brick Clay* is equally objectionable, since clay capable of making bricks may belong to any period, and the brick clay of one part of the country may be geologically distinct from that of another. The use of the term *Till* is also in danger of misleading through its employment by the older Scotch geologists in a very vague sense; in fact, whenever a bed of coarse silt, or clay, or sandy loam was found containing boulders it was called *Till*.

While retaining the term "Boulder Clay," we cannot employ it without considerable explanation. If we were to content ourselves with noting that certain species of Ostracoda occur *in* the "Boulder Clay," or *beneath* the "Boulder Clay," without specifying the precise character of the deposit to which we refer, it would lead to great confusion. Under the general term "Boulder Clay" a very miscellaneous collection of deposits, attributable to different causes and belonging to various periods of the great Glacial Epoch, has been vaguely included. Any clay containing boulders is not necessarily identical with the oldest Boulder Clay of Scotland. A fossiliferous Arctic clay may contain boulders (as boulders may be found scattered through the Paisley Shell-beds), and yet cannot be described as Boulder Clay without an extreme misuse of terms. Boulders have been in all probability dropped into the Shell Clay from ice floating over the Firth of Clyde, precisely as they are dropped from the ice floating at the present day in the St. Lawrence, and this Shell Clay, into which the boulders fell, *may* have been resting upon an old "Boulder Clay" and have been formed long subsequently to its deposition and by entirely different agencies. A "Boulder Clay" *may* have been carried from the land into the sea by a glacier breaking off into an iceberg, and thus have covered littoral Shell Clays, and have become mixed with fragments of shells, although not itself of marine origin.

Without theorizing, therefore, upon the origin of the various beds roughly included under the general terms "Northern Drift," "Brick Clay," "Till," "Boulder Clay," it is necessary to note their characteristics in order that the physical geologist may understand the exact positions in which the Ostracoda we catalogue occur.<sup>1</sup>

<sup>1</sup> These deposits have been treated of to some extent in the series of Memoirs on the Post-tertiary fossiliferous beds of Scotland, by Messrs. Crosskey and Robertson, in the 'Transactions of the Geological Society of Glasgow,' vol. ii, p. 267; vol. iii, pp. 113, 321; and vol. iv, pp. 40, 128. See also Mr. Crosskey's paper on the Boulder Clay, *ibid.*, vol. iii, p. 149.

## § I. VARIETIES OF BOULDER-CLAY.

I.—One bed is so distinct in character and so easily recognised that one of the writers of these pages proposed, some years ago, that to it the term "Boulder Clay" should be entirely restricted,<sup>1</sup> and this course will be followed in the present Monograph.

This Boulder Clay contains a large number of striated and polished stones which have been worn down, and not broken, by the process through which they have passed. These polished and striated surfaces are so freshly preserved that the stones could not have been rolled on a beach subsequently to their production. Any trituration would at once destroy the fineness of the glaciated surfaces.

The included stones are chiefly traceable to the heights nearest the locality in which the special bed under examination is found, although a distinct proportion have been derived from the more distant mountains. In some cases the included boulders have travelled from distances in the direction along which a glacier would naturally have moved, according to the general conformation of the country.

The colour, as well as the general character of the enclosed stones, is determined by the mineral character of the district in which it is found.

There is no distinct stratification, although there are occasional seams of sand and clay. The Boulder Clay varies in tenacity; but, as a rule, is toughly compact and hard to be worked even with a pick-axe.

Its thickness is excessively variable, extending from a mere surface-covering of the rock to a depth of one or two hundred feet.

The highest point at which the stratified clay containing glacial shells has yet been found in Scotland is at Chappel Hall, near Airdrie, 526 feet above the sea; but an unstratified and unfossiliferous Boulder Clay, of the character just described, may be traced to very considerable heights. It has been seen by Mr. J. Geikie on the tops of the Ochils, 1500 feet; by Mr. Croll on the Pentland Hills, 1617 feet; by Mr. Milne Home, near Scheshallion, 2000 feet above the sea; and it may be found in almost every nook and corner of the Highlands. At lower levels it is very largely developed, both in the plains themselves and on the flanks of the hills bordering wide valleys.

While this Boulder Clay reaches to a height of at least 1500 feet beyond that at which any arctic shell-clay has yet been discovered, it at the same time *underlies* the shell-bed throughout the whole of the west of Scotland, as well as in some of the Eastern districts. Many instances of this fact will be noted in the detailed descriptions

<sup>1</sup> See a paper "On the *Tellina calcarea* Bed at Chappel Hall, near Airdrie," by Henry W. Crosskey, in the 'Quarterly Journal Geolog. Soc.,' 1865, vol. xxi, p. 219.



of the beds we have examined. Shell-beds have also been found, under circumstances needing special local examination, intercalated between masses of Boulder Clay of the same character.

The only cases in which a Boulder Clay physically analogous to that of which we are treating contains fossils are those which will presently be described as a second type of Boulder Clay, which forms cliffs near the shore and never extends beyond a few miles inland.

Whatever explanation of its origin may be given, so far as present investigations extend, there seems to be ample evidence for the existence of a Boulder Clay: (1) Older than the stratified clay containing Arctic shells; (2) extending to far greater heights than either any fossiliferous Boulder Clay or any stratified clay; (3) unsubjected to any action of the tidal wave upon the shore; (4) and connected with the more remote and extreme Arctic conditions of the Glacial Epoch.

*The position of the beds from which we have obtained Ostracoda in relation to this Boulder Clay* will at any rate furnish a guide available for the practical use of the advocates of any theory regarding their succession, which may be in debate.

## II. There are *fossiliferous Boulder Clays* which have several striking peculiarities.

1. They occur (so far as we yet know) either close to the coast or within a distance of four or five miles, and generally form low cliffs immediately on the shore. They may be seen on the north-east coast of Scotland, along the north-east coast of Ireland, on the north-east coast of England, on the Lancashire coast, and along the banks of the Mersey.

2. The shells they contain are very seldom perfect, except in the case of a univalve, like *Turritella communis*; and, even when perfect, they are not found in their natural living position. These features form a remarkable contrast to the state of the fossils in the great shelly beds resting upon the Boulder Clay in the Clyde districts. In those beds numerous specimens of such Molluscs as *Saxicava (Panopæa) Norvegica*, and *Mya Uddevallensis* are found in their natural upright position, with fragments of the syphon preserved; while *Pecten Islandicus*, *Astarte sulcata*, and almost every other bivalve, together with the Ostracoda, occur with united valves; and in many cases, when they are taken freshly from the clay, the connecting ligament may be detected, although it quickly decays on exposure to the air.

3. The fauna is sometimes less Arctic in character than that yielded by the stratified glacial clay immediately resting upon the lowest unstratified Boulder Clay. The Caithness Boulder Clay, which reaches a thickness of more than 100 feet, contains (writes Mr. Jamieson) "remains of sea shells all through it, often from top to bottom, and these shells are broken, rubbed, and scratched, evidently by the same agency that marked the rocks and boulders," while "the group is the most modern, except that of

Fort William," and "the proportion of Arctic species is less than at any of the other localities."<sup>1</sup>

Mr. Jamieson gives the following explanation of the probable origin of the Caithness fossiliferous Boulder Clay:—"A set of marine beds containing Arctic shells were probably deposited over the low part of Caithness; and much drifting ice seems to have passed over the district from the north-west, which crushed and destroyed these marine beds, broke the shells, and mixed them up with other superficial *débris* into that mass of rough pebbly mud which now overspreads the surface. These marine beds were probably of different ages; the older containing Arctic species, the later containing chiefly Boreal and southern forms. This would account for that mixture of species which we observe in the Caithness list."<sup>1</sup>

4. The fauna, also in *some* of the fossiliferous Boulder Clays, is somewhat mixed.

Foraminifera, *e.g.*, are found in the Caithness Boulder Clays, which have been derived from the wearing down of the oolite, lias, and chalk blocks they contain. In the same clays there is also a mixture of southern, British, northern, Arctic, and North-east American species of Mollusca.<sup>2</sup>

While this Boulder Clay possesses the general appearance of the Boulder Clay first described, containing the usual striated and polished stones and being compact and unworkable, these characteristics may fairly be described as, in many instances, not quite so intense in their development, although often their only distinguishing mark is the presence of shell fragments.

Its peculiar position in cliffs near the shore, the occurrence of fossils, and its general composition, seem to sustain the theory that in some cases it marks the point where the *débris* of great glaciers was pressed to the bottom of the sea at their final point of descent; and it may be of the same age as the shell-beds, which, in other localities, rest in hollows of the unfossiliferous Boulder Clay; while in other cases it may be an accumulation dropped from icebergs, and in others a wash from an older bed during the final re-elevation of the land.

Without reference, however, to the method of its formation, as a matter of fact there exists a fossiliferous Boulder Clay (1) not *necessarily* of the same age as the unfossiliferous Boulder Clay; (2) with an included fauna more or less Arctic, although mixed and fragmentary; (3) chiefly developed in the neighbourhood of the shore, in the form of sea cliffs; (4) physically, not always distinguishable from that which underlies the Shell Clay of the Clyde district, although sometimes marked by a diminution in the intensity of its ice-marks.

<sup>1</sup> "On the Glacial Phenomena of Caithness," by T. F. Jamieson, F.G.S., 'Quarterly Journal of Geol. Soc.', 1866, vol. xxii, pp. 272, 273.

<sup>2</sup> Jamieson, paper cited, p. 278.

## 1. WICK HARBOUR.

We examined the fossiliferous Boulder Clay at Wick Harbour and Burn of Haster, for Ostracoda. It is a hard compact mass with striated and polished boulders, similar in composition to that Boulder Clay in the west of Scotland, in which we have failed as yet to detect fossils. We are unable to make any physical distinction between the two Boulder Clays now mentioned.

The Caithness Boulder Clay varies in depth and is generally overlain by shingly gravel, succeeded by surface soil. The fossils are thinly interspersed from top to bottom through the section, and are very much worn and fragmentary. They appear very equally distributed, as if the whole mass had been mixed up and kneaded together, and can be obtained, although sparingly, on the face of weather-beaten sections. On some strong valves of *Cyprina Islandica* glacial striæ may be observed.

Mr. Jamieson gives the following section at Wick Harbour :

1. Reddish-brown clay, with boulders ;
2. Dark pebbly silt, with broken shells ;
3. Old Red Sandstone ;

and adds the following description : " In the banks beside the harbour (at Pulteney Town) the drift is fifty or sixty feet deep. The lowermost two thirds of it are a sandy mud or silt of a very dark grey colour, solid and firm, as if much compressed, and although there are a good many small pebbles dispersed through it, yet they do not form a large proportion of the mass, and there is an absence of big stones. Fragments of shells are in many places not uncommon, and are scattered through it in an irregular manner, not occurring in horizontal lines or seams. There is, in short, no distinct stratification, although in some places there is an approach to it, owing to patches of a more sandy nature occurring ; it is an unstratified pebbly silt, the greater part of the mass consisting of fine sand. The upper part of the bank, on the other hand, is of a browner, more ferruginous colour, much coarser in quality, with more muddy sediment, and few or no shells ; it is also full of stones and large ice-worn boulders of sandstone, quartzose mica-schist, and granite, on which the glacial scoring is well marked ; one of these granite blocks is twelve feet in length. I cannot say that there is any clear line of separation between this coarse upper stuff and the dark siltier matter beneath ; for although in some places the distinction is pretty well marked, in others they seem to graduate into each other. When the rock rises in the cliff, the dark silty portion thins out, and the coarse brown mud full of boulders rests immediately upon the ice-worn surface of the Caithness flags."<sup>1</sup>

We washed 12 lbs. of the dry shell-bearing clay, and found that it lost 4 lbs. through a sieve of ninety-six threads to the inch, leaving 8 lbs. residue, of which 2 lbs.

<sup>1</sup> 'Quarterly Journal of Geol. Soc.,' 1866, vol. xxii, p. 265.

was retained in a sieve of one eighth of an inch mesh, and consisted of small stones more or less worn and striated. The remaining 6 lbs. was chiefly sand.

The following Ostracoda were found :

- Cythere viridis*, Müller.
- *mirabilis*, Brady.
- *Dunelmensis* (Norman).
- *tuberculata* (G. O. Sars).
- *tenera*, Brady.
- *lutea*, Müller.
- Cytheridea punctillata*, Brady.
- *papillosa*, Bosquet.
- Loxoconcha impressa* (Baird).
- Cytherura undata*, G. O. Sars.
- Cytheropteron latissimum* (Norman).

## 2. BURN OF HASTER.

Along the banks of the Burn of Haster, near Wick, Mollusca are more abundant than at Wick Harbour, although the Boulder Clay is very coarse and contains many stones of large size.

The following Ostracoda were found :

- Cythere villosa* (G. O. Sars).
- *concinna*, Jones.
- *Finmarchica* (G. O. Sars).
- Cytheridea punctillata*, Brady.
- Xestoleberis depressa*, G. O. Sars.
- Cytherura undata*, G. O. Sars.
- Cytherideis subspiralis*, nov. sp.

III. A third clay, which has been improperly, we believe, termed Boulder Clay, is precisely of the same age, although not of the same physical character, as the stratified shell-bearing clays of the Clyde and other districts. An example may be seen near Lag Arran, overlying the older Boulder Clay from which it is very distinctly separated; it is hard and compact, but not so hard and compact as the clay on which it rests, while the stones it contains are generally smaller, much more worn, and, except in a few

exceptional cases, far less distinctly striated. The Arctic shells found scattered through it, although chiefly in single valves and broken, are decidedly better preserved than in the fossiliferous Boulder Clay just described. A *Leda*, indeed, has been found with both valves united, and the bed contains species as characteristic of the ordinary Glacial Clays as *Pecten Islandicus*, *Astarte borealis*, *Leda pernula*, *Cyprina Islandica*, together with Foraminifera and Ostracoda. Patches of sand and gravel are common. This clay is evidently the wash of an old Boulder Clay upon a somewhat exposed coast. The angular blocks have been jumbled together, their striations half obliterated, and their polish somewhat worn off, while the clay has been washed and rewashed around them, and a rude and rough habitat formed for the scanty development of a marine fauna. In an account of these beds given by Dr. Bryce and one of the authors of this paper,<sup>1</sup> it is pointed out that the upper part of the shell-bed is a little sandy, while in the lower part the character more closely approximates to the underlying Boulder Clay.<sup>2</sup>

The following Ostracoda were found in the shell-bearing clay, of the character now described, on the banks of the Cloinid Burn, near Lag Arran. A complete section of the bank will be given as we proceed to notice the next division of so-called Boulder Clays:

- Cythere pellucida*, Baird.
- *concinna*, Jones.
- *Clutha*, nov. sp.
- *emarginata* (G. O. Sars).
- *Dunelmensis* (Norman).
- Cytheridea punctillata*, Brady.
- *papillosa*, Bosquet.
- Cytherura nigrescens* (Baird).
- *undata*, G. O. Sars.
- Cytheropteron nodosum*, Brady.

IV. A series of deposits composed of sand, gravel, and clay, and containing boulders often in large numbers, must be carefully discriminated from the "Boulder Clay" of this paper.

Instead of the innumerable finely polished and striated stones characteristic of the "Boulder Clay," these beds contain stones with coarsely worn surfaces and half oblite-

<sup>1</sup> 'Arran and other Clyde Islands,' by J. Bryce, LL.D., 4th ed., p. 184.

<sup>2</sup> A different view of this clay is taken by the Rev. R. B. Watson, B.A., in his paper "On the Great Drift Beds with Shells in the South of Arran," 'Trans. Royal Soc. Edin.,' vol. xxiii, p. 523.

rated striæ, while many retain no signs of ice-action. Differing in texture, they are often loose and rubbishy—sandy and earthy—and to a large extent have been exposed to the wear and tear of air and water.

They sometimes contain blocks even larger and heavier than those in the lower clay; but these blocks *may* have been dropped into the bed by floating ice.

1.—Some of the beds of this series consist of a thick clay with many boulders, and on a cursory examination might easily be mistaken for "Boulder Clay" in the sense in which we have employed the term. They may be distinguished, however, by observing that the included stones while often angular and subangular, have a feeble polish, and preserve only faint reminiscences of their former striations. Generally speaking, also, the clay and the boulders are far less compactly pressed together, and are not welded, like the old Boulder Clay, into an almost solid mass.

Sometimes a shell bed may be seen intervening between an upper bed of this kind and a lower Boulder Clay; and at other times the two clay beds may be seen in contact, the shell bed having been eliminated.

During some excavations at Chappel Hall, near Airdrie, the following sections were exposed within seven yards of each other

|   | ft. | in. |
|---|-----|-----|
| Upper clay with boulders . . . . .  | 14  | 0   |
| Finer clay, containing smaller stones, with <i>Tellina calcarea</i> and <i>Cyprina Islandica</i> ; in the deepest part (but rapidly thinning out) . . . . . | 2   | 1   |
| Boulder Clay, not pierced.  |     |     |

At seven yards' distance the shell bed disappeared and the two clays met.

|   |   |   |
|---|---|---|
| Upper clay with boulders . . . . .          | 5 | 3 |
| Boulder Clay, not pierced through . . . . . | 9 | 6 |

We carefully examined these two clays, and found the distinctions between them very decidedly marked. The boulders in the lower bed were polished with extreme fineness, and the striations upon them were numerous and clear, but in the upper bed only a few stones had slight indications of striæ, while many had the appearance of having been worn down. The upper clay was also looser and more easily worked than the lower.

2.—Other beds of this series are composed of sand and gravel rather than clay, and are either unstratified or very rudely stratified, and often contain angular and imperfectly stratified boulders.

Between these beds also and the older Boulder Clay shell beds have been discovered. The following section occurs along the banks of the Cloinid burn, near Lag Arran.<sup>1</sup>

- |   |                     |  |
|---|---------------------|--|
| 1. Surface soil.                                |                     |  |
| 2. Upper drift of sand and stones . . .         | variable thickness. |  |
| 3. Compact bed of stones with little sand . . . | 5 to 6 ft.          |  |
| 4. Upper drift of sand and stones . . .         | variable thickness. |  |
| 5. Dark sandy bed with open texture . . .       | 4 to 5 ft.          |  |
| 6. Stony clay bed, with Arctic shells . . .     | 7 to 10 ft.         |  |
| 7. Boulder Clay . . .                           | 12 to 20 ft.        |  |

In this section we may see in regular and ascending order—

An older Boulder Clay (I of this paper, p. 3), unfossiliferous and typical.

A fossiliferous clay (III of this paper, p. 7); a wash from an older bed, with a scattering of striated stones.

A younger series of clays, sands, and gravels (IV of this paper, p. 8); unfossiliferous (in this case), loose and sandy, and retaining some feebly striated stones.

From the diverse characteristics of the deposits now described, and which have all been included more or less generally under the terms—Till, Northern Drift, Boulder Clay, it is evidently of the utmost importance that precise descriptions of the clays in which Ostracoda and other fossils have been discovered should be given. Employing a vague nomenclature, a species may be said to occur *in* the Boulder Clay, and yet have been found either in the second or third or fourth of the beds discriminated in this paper; or a species may be said to occur *under* the Boulder Clay, and have been found under the first or the fourth.

A fossil really belonging to the age of the Paisley Clay might thus, for example, be ascribed to a more remote or a more recent era almost *ad libitum*, to the great confusion of any attempts to understand either the variations of climate or the distribution of species which may have taken place during the Glacial Epoch and the subsequent physical history of Great Britain.

<sup>1</sup> Bryce, 'Arran,' &c., p. 185.

## § II. VARIETIES OF FOSSILIFEROUS DEPOSITS, NOT BEING BOULDER-CLAYS.

NECESSARY as it is to distinguish the so-called "Boulder Clays" from each other, it is equally necessary to note the differences existing between those numerous Post-tertiary fossiliferous deposits of Scotland which cannot under any circumstances be described as Boulder Clays, and in the larger number of which Ostracoda occur in more or less abundance.

In the earlier researches into the Post-tertiary beds of Scotland two superficial deposits alone were noted. The lowest was vaguely termed "Till, a stiff unstratified clay mixed with boulders," while the upper was described as brick or finely laminated clay overlain by sand and gravel. The whole of the fossils found were classed together and catalogued by Mr. Smith of Jordan Hill, in the first catalogue ever issued,<sup>1</sup> as belonging to the "Newer Pliocene deposits in the British Islands."

As Mr. Smith's investigations proceeded he discovered that he had confounded two distinct sets of beds, and that there were in the elevated marine beds of sand, gravel, and clay, which cover the older formations, *at least* two deposits differing in climate and fauna, and separated by wide intervals of time.<sup>2</sup> He discriminated the "glacial deposits" of Great Britain and Ireland from the "raised beaches," and a Glacial Epoch was added to the geological record.

Mr. Smith published a second catalogue in which he confined himself to the marine Testacea, including Cirripedia, Annelida, and Foraminifera"—Ostracoda had not then been detected—of the "glacial deposits."<sup>3</sup> This catalogue, however, presents many difficulties. Apart from the fact that there is a very perplexing employment of synonyms, the original specimens from which several "new species" were described have not been preserved, so that it is impossible to decide whether some of them may not have been identical with the varieties of modern conchologists, and many of the *localities* are far too vaguely specified for identification.

The simple distinction between "raised beaches" and "glacial deposits" does not at all cover the whole ground occupied by the fossiliferous beds in question.

<sup>1</sup> 'Transactions of the Wernerian Society.' 1839.

<sup>2</sup> 'Researches in Newer Pliocene and Post-tertiary Geology.' By James Smith, F.R.S. Glasgow: John Gray. 1862.

<sup>3</sup> Ibid., p. 46. In connection with this department of Scotch Geology, the name of Mr. Smith ought always to be honourably remembered, and the results of his researches acknowledged. His collected papers indicate the successive steps which led to his great discovery, and constitute a chapter of great value in the history of Post-tertiary geology. •



Professor Edward Forbes, in his paper "On the Connection between the Distribution of the Existing Fauna and Flora of the British Isles and the Geological Changes which have affected their area, especially during the Epoch of the Northern Drift,"<sup>1</sup> while referring in his catalogue of "species of marine animals found fossil in beds of the Glacial Epoch" to localities so broadly defined as "Scotland," "drift beds of Scotland and Ireland," and "Clyde beds," nevertheless, by the whole course of his arguments plainly indicates that these beds themselves must differ from each other in their general characteristics, and require to be studied separately rather than be roughly gathered into one group.

Among the "chief conclusions" (some of which subsequent researches have necessarily modified) in which he sums up the results of the facts and arguments stated in the essay the following occur, which bear upon the existence, among the Post-tertiary fossiliferous deposits under discussion, of many varieties of beds deposited neither at one time nor under one set of circumstances.

"The greater part of the terrestrial animals and flowering plants now inhabiting the British Islands are members of specific centres beyond their area, and have migrated to it over continuous land before, during, or after the Glacial Epoch" (p. 399).

"The termination of the Glacial Epoch in Europe was marked by a recession of an Arctic fauna and flora northwards, and of a fauna and flora of the Mediterranean southwards, and in the interspace thus produced there appeared on land the general Germanic fauna and flora, and in the sea that fauna termed Celtic" (p. 401).

"The causes which thus preceded the appearance of a new assemblage of organized beings were the destruction of many species of animals, and probably also of plants, either forms of extremely local distribution or such as were not capable of enduring many changes of conditions,—species, in short, with very limited capacity for horizontal or vertical diffusion" (p. 401).

"All the changes before, during, and after the Glacial Epoch appear to have been gradual and not sudden, so that no marked line of demarcation can be drawn between the creatures inhabiting the same element and the same locality during two proximate periods" (p. 401).

The recession of one fauna and flora and the advance of another, the changes in the local distribution of species caused by the elevation and subsidence of the land, and the gradual passage from one set of conditions to another, must be indicated in the varying composition of the different deposits.

The first important attempt to classify the various beds belonging to the "Scotch glacial drift," as well as explain their origin and determine their sequence, was made by Prof. A. Geikie, whose treatise "On the Phenomena of the Glacial Drift of Scotland" was published in 1863.<sup>2</sup>

<sup>1</sup> 'Memoirs of the Geological Survey of Great Britain,' vol. i. London, 1846.

<sup>2</sup> 'Transactions of Geological Society of Glasgow,' vol. i, part ii.

Other investigators, including Mr. Jamieson, of Aberdeen, Mr. Croll, Mr. Milne Home, Mr. James Geikie, and many other geologists, have largely advanced our knowledge; and the reader may be referred to many papers which during the last few years have appeared in almost every volume of the 'Transactions of the Geological Society of Glasgow;' 'Transactions of the Philosophical Society of Glasgow;' 'Transactions of the Royal Society of Edinburgh;' 'Transactions of the Geological Society of Edinburgh;' 'Proceedings of the Royal Physical Society of Edinburgh;' 'Geological Magazine;' 'Quarterly Journal of the Geological Society,' &c.

We proceed to describe the various fossiliferous deposits, not being Boulder Clays, which have come under examination for the purposes of this paper.

There are various striking differences both in position and character existing among the Post-tertiary fossiliferous glacial clays, sands, and gravels, which raise questions of great intricacy and importance, and by which (at any rate for the purposes of study) they must be more or less distinctly separated from each other.

In the following remarks (as well as throughout this paper) we mean by "Boulder Clay" the first clay which we described<sup>1</sup> among the varieties to which that name has been affixed.<sup>2</sup>

*I. Fossiliferous beds, the remains either of the immediate Pre-glacial period or Inter-glacial or Glacial, have been discovered immediately beneath the Boulder Clay, and without any Boulder Clay for their base.*

The fact of the occurrence of these fossiliferous beds in this position does not, of course, either prove them to belong to one epoch or determine their precise age at all, but its significance will be illustrated by the following examples.

#### 1. SLAINS AND CRUDEN, ABERDEENSHIRE.

In the parishes of Slains and Cruden, on the east coast of Aberdeenshire, some thick masses of sand and gravel have been described by Mr. Jamieson, ranging up to 200 feet above the sea-level, which are covered in many places "by the red clay of the Glacial Period, containing large boulders and ice-scratched stones," and have no Boulder Clay below them, and which contain a fauna allied to that of the Crag strata of England.<sup>3</sup>

There can be no doubt that the group of species mentioned in the following passage

<sup>1</sup> See page 3.

<sup>2</sup> Mr. James Geikie, in his elaborate and remarkable work on "The Great Ice Age," which has been published while these pages are passing through the press, restricts the term *Till* to the *Boulder Clay* of this paper.

<sup>3</sup> 'Quarterly Journal Geol. Soc.,' 1865, vol. xxi, p. 161.

is entirely different from any group discovered either in the older glacial or the more recent deposits of Scotland.

"There are fragments of *Voluta Lamberti*, *Cyprina rustica*, *Nucula Cobboldiæ*, *Fusus contrarius*, *Purpura incrassata*, *Nassa elegans*, *Nassa reticosa*, *Turritella incrassata*, and probably *Trophon costiferum*, forms unknown either in our glacial beds or in our present sea. Besides these there are the broken remains of many others, of the genera *Cardium*, *Pecten*, *Venus*, and *Astarte*, which differ from those found in any of our glacial beds, and one of the most common shells is *Pectunculus glycimeris*, which attained a large size."<sup>1</sup>

## 2. KILMAURS, NEAR KILMARNOCK.

Messrs. John Young and Robert Craig have published notes "On the occurrence of Freshwater Plants and Arctic Shells, along with the remains of the Mammoth and Reindeer, in beds under the Boulder Clay at Kilmaurs."<sup>2</sup>

Since the discovery (1816) of the remains of *Elephas primigenius* and *Cervus tarandus* at Woodhill quarry, Kilmaurs, near Kilmarnock, considerable interest has attached to the beds underlying the Boulder Clay in this neighbourhood. Dr. Bryce has published<sup>3</sup> the following section of beds exposed during excavations made under his direction. One of the writers of this paper noted the section in company with Dr. Bryce, and is perfectly satisfied that the sixteen feet of Boulder Clay consist of precisely the same clay as that unfossiliferous Boulder Clay we have described and to which we limit the term.

1. Carboniferous Sandstone, terminating upwards in beds of sandy clay, resembling a fire-clay . . . . .
2. Hard gravel, with a little clay, and small bits of round smooth stones, most of them quartz and trap, but all free from striation . . . . . 2 ft.
3. A fine dark-blue clay, with occasionally small bits of quartz and other pebbles, extremely distinct in character . . . . . 9 in.
4. Sand, irregular in structure, very fine in places and again coarse, approaching gravel, very like river-sand . . . . . 6 to 18 in.
5. Boulder-clay, of reddish-brown colour, very tough and unworkable, full of large boulders and smaller stones, mostly smoothed, polished, and striated; bits of coal-shale, covered with striations, not crushed . . . . . 16 ft.
6. Upper Drift, with stones, but much more open in texture, no striations . . . . . 20 ft.
7. Subsoil and surface soil.

<sup>1</sup> 'On the Hist. of the last Geol. Changes in Scotland,' by T. F. Jamieson, F.R.S., p. 162.

<sup>2</sup> 'Transactions of the Geol. Soc. of Glasgow,' vol. iii, p. 310.

<sup>3</sup> "On the Occurrence of Beds in the West of Scotland beneath the Boulder Clay," by James Bryce, M.A., LL.D., F.G.S., 'Quart. Journ. Geol. Soc.,' vol. xxi, 1865, p. 213.

During this excavation no fossils were found, but *from the same quarry* a tusk of *Elephas primigenius* and a pair of horns of *Cervus tarandus* were sent some years ago to the Hunterian Museum (University of Glasgow), with a statement that they had been found at a *depth of thirty-four feet from the surface*. By washing some sandy clay in which the horns were embedded, and also the clay preserved in the cracks and crevices in the tusk, Messrs. Craig and Young have discovered (1) that the specimens came from the same bed, and (2) that this bed was of freshwater origin, and quite distinct from any bed containing marine shells.

It appears clearly proved, therefore, that there exists in this district, *beneath the old Boulder Clay*, a freshwater bed containing the remains of *E. primigenius* and *C. tarandus*.

New pits having been sunk, Messrs. Craig and Young have been able to throw fresh light on those beds beneath the Boulder Clay we are now discussing.<sup>1</sup>

At No. 9, Woodhill, Kilmaurs, about half a mile from the old Woodhill quarry, the following beds were pierced:

|   |             |
|---|-------------|
| Surface-drift and Boulder-clay            | 50 ft.      |
| Sand bed, containing Arctic marine shells | 1 ft. 3 in. |
| Sandy peaty clay, about                   | 1 ft.       |
| Coarse gravelly sand                      | 1 ft. 6 in. |
| Carboniferous strata.                     |             |

Every one of the nine species of Mollusca found in this sand bed also occurs in the glacial clay, resting in hollows of the Boulder Clay (of which we shall presently speak), so that the bed is entirely different from Mr. Jamieson's Aberdeenshire "pre-glacial" sand and gravel, although it occupies the same position relatively to the Boulder Clay.

The same remark applies to a sand bed found beneath the Boulder Clay at a pit 250 yards south-east from No. 9 pit, where the section is—

|   |        |
|---|--------|
| Surface-drift and Boulder-clay            | 42 ft. |
| Sand bed, with Arctic shells              | 5 ft.  |
| Clay-shale, the roof of the "Major Coal." |        |

In this pit the coarse gravelly sand and sand and peaty clay of the neighbouring pit are absent.<sup>2</sup>

Messrs. Craig and Young believe that the freshwater bed, containing mammalian remains, is situated beneath the Arctic shell-sand, and consequently conclude that the land has suffered a long submergence since the mammoth and the reindeer existed in the pre-glacial valley of the Carmel at Kilmaurs, but for their ingenious argument on this point we must refer to the paper already cited.

<sup>1</sup> 'Trans. Geol. Soc. Glasgow,' vol. iii, p. 315.

<sup>2</sup> Ibid., p. 316.

The following Ostracoda were found :

*Cythere concinna*, Jones.

*Cytheridea punctillata*, Brady.

### 3. TANGY GLEN, NEAR CAMPBELTOWN.

In Tangy Glen, about six miles from Campbeltown on the road to Tarbert, about 300 yards up the little stream, at a point where it turns eastwards, and 130 feet above the sea-level, the water has cut deeply into the bank, exposing a cliff of Boulder Clay rising to the height of upwards of 100 feet.

This Boulder Clay is of the most pronounced type, stiff, compact, and full of highly striated stones of various sizes. At one part a finer or more sandy bed, gradually thinning out, is intercalated with the clay; and such lenticular beds are not uncommon in the Boulder Clays of the West of Scotland. Within this Boulder Clay, and covered by it, a stratified shell-bearing clay is seen standing up like a boss or knoll, and has doubtless been brought to this form by abrasion. At the point of greatest exposure it is thirteen feet high; and it can be traced, as it thins down along the edge of the streamlet, for a distance of sixty or seventy yards. The exact depth could not be ascertained; but, as the rock is seen at a short distance on either hand, it is probably not more than a few feet deeper than the actual exposure, and we could detect no Boulder Clay beneath it. The shell-bearing clay is dark grey in colour, and contrasts strongly with the underlying Boulder Clay, which is of a full reddish-brown.

#### *Boulder Clay.*

|              |                           |
|--------------|---------------------------|
| 50 per cent. | fine mud.                 |
| 27    ,,     | sand (21 fine, 6 coarse). |
| 23    ,,     | gravel.                   |

#### *Shell-bearing Clay.*

|              |            |
|--------------|------------|
| 80 per cent. | fine mud.  |
| 14    ,,     | fine sand. |
| 6    ,,      | gravel.    |

The fossils in this deposit are but sparingly met with—Mollusca especially are comparatively rare—*Leda pygmæa* being the prevailing shell, with an occasional *Leda pernula*, *Venus ovata*, *Corbula gibba*. Some species, however, are of an extremely Arctic character, and while somewhat common in the glacial beds on the east coast, are very seldom met with in the west of Scotland. *Pecten Grænländicus*, *e.g.*, is common at Montrose, Errol, and Elie, but in the west we have only seen it at Tangy. It is remarkable that at Montrose it is only obtained at a great depth, seldom less than thirty or forty feet, but at Elie it is found only a few feet beneath the surface and within reach of the tide, and in neither of these cases beneath the Boulder Clay; while at Tangy it is beneath Boulder Clay, and 130 feet above the present sea-level.

*Montacuta elevata*, an Arctic species, very rare in the glacial clays of Britain, also occurs. The Ostracoda (of which we collected twenty-three species to be presently enumerated) have much in common with those found in the clays on the east coast of Scotland, which represent more strongly Arctic types than those generally found in the west. Amongst these are—

*Cytheropteron Montrosiense*, nov. sp.  
*Cytheridea Sorbyana*, Jones.

Only one of these has yet been found in the glacial clays of the west of Scotland—*C. Montrosiense*, which we obtained at a depth of eighteen feet from a glacial clay, dipping away from the Clyde, near Govan. *C. Sorbyana* is a common species in the glacial clays of Norway.

There is little doubt, however, that these species will be at some time found in a western clay, just as we have found in a pit in Ayrshire a solitary specimen of *Leda arctica*, which is the characteristic shell of the Errol clay on the west, but the fact of their extreme rarity, to say the least, in the west and abundance in the east is full of significance.

Height above the sea 130 feet.

The following Ostracoda were found :

*Cythere castanea*, G. O. Sars.  
 — *lutea*, Müller.  
 — *limicola* (Norman).  
 — *globulifera*, Brady.  
 — *concinna*, Jones.  
 — *Dunelmensis* (Norman).  
*Cytheridea papillosa*, Bosquet.  
 — *Sorbyana*, Jones.  
*Cytherura nigrescens* (Baird).  
 — *undata*, G. O. Sars.  
 — *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
 — *arcuatum*, nov. sp.  
 — *Montrosiense*, nov. sp.  
*Bythocythere constricta*, G. O. Sars.  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma variabile* (Baird).

## 4. KING EDWARD, ABERDEENSHIRE.

A shell-bearing silt is in this section covered by a thick mass of Boulder Clay, *which is fossiliferous in its lower portion only*; but, as its base has not been exposed, it is uncertain whether any Boulder Clay extends beneath it.

Mr. Jamieson gives the following section, and remarks that the broken shells in the lower part of the coarse upper drift appear to have been derived from the glacial marine silt below, in which the shells are *in situ*.

|  | Feet.    |
|--|----------|
| 1. Water-worn gravel and sand, stratified, often rather coarse and pebbly, and somewhat ferruginous. Contains no fossils . . . . .   | 10 to 25 |
| 2. Unstratified pebbly mud of a dark-grey tint, hard, and difficult to pierce. The stones in it are of small size, but numerous, and some of them are glacially scratched. In the upper part I could see no shells; but shell fragments occur in the lower part, increasing in numbers towards the base. Some of the shell fragments show distinct traces of glacial action . . . . .  | 20 to 30 |
| 3. Fine brownish sand, in some places rich in shells. This sand is interstratified with the upper part of the subjacent bed . . . . .  | 1 to 2   |
| 4. Fine dark-grey silt, free from stones, containing Arctic shells complete, and apparently <i>in situ</i> . . . . . This silt is very firm, as if much compressed, and the greater proportion of it consists of fine muddy sand. The base of this bed has not been exposed, but it has been excavated . . . . . to a depth of ten feet. No difference in the quality is to be seen to this depth; no stones. The upper surface of this silt is about 150 feet above the sea. <sup>1</sup> |          |

Mr. Jamieson classes the fossils found at King Edward with the Paisley, Kilchattan, and Gamrie groups, as being less intensely Arctic (as we shall also have occasion to remark when describing the Ostracoda) than the Errol and Elie groups.

Height above the sea 150 to 200 feet.

<sup>1</sup> 'Quarterly Journal Geol. Soc.,' 1866, vol. xxii, p. 275.

The following Ostracoda were found :

- Cythere tuberculata* (G. O. Sars).  
 — *Dunelmensis* (Norman).  
*Cytheridea papillosa*, Bosquet.  
 — *punctillata*, Brady.  
 — *Sorbyana*, Jones.  
*Cytheropteron Montrosiense*, nov. sp.

5. Thus the following classes of fossiliferous beds may be found *beneath* the Boulder Clay, and without any observed Boulder Clay for their base :

- a. Marine sands and gravels more allied to the English Crag than to the glacial clays.
- b. Beds of freshwater origin with the remains of *Elephas primigenius* and *Cervus tarandus*.
- c. Marine beds containing the common Arctic fauna of the Clyde glacial beds.
- d. Marine beds which have been broken up by some disturbing force, and some of the shells from which have been mixed with the Boulder Clay under which they were finally crushed.

It does not *necessarily* follow from the mere position of any one of these beds beneath a Boulder Clay that it must belong to an "interglacial" period ; many other considerations are needed to determine this point. A Boulder Clay may have been deposited upon a shell bed during some interglacial period, or during the later part of the glacial marine period, according to the local circumstances of the case ; or it may even have been thrown upon it by an accidental displacement long after its own original formation.

II. *Fossiliferous beds have been also found, situated between masses of Boulder Clay, which have been referred (together with other sand and gravels) to a series of " Interglacial deposits."*<sup>1</sup>

The actual occurrence of fossiliferous beds between masses of Boulder Clay does not prove that all such beds belong to the same period, or even that they were deposited in the *middle* of the Glacial Epoch itself.

It is possible (as instanced in Caithness) that drifting ice should have passed over a

<sup>1</sup> 'On Changes of Climate during the Glacial Epoch.' By James Geikie, F.R.S.E. Trübner and Co., 1872.—'The Great Ice Age.' By James Geikie, F.R.S.E. W. Isbister and Co., London.



shell bed of the same age, to say the least, as the later Clyde shell beds, and have deposited Boulder Clay upon it.

Whether this actually happened or not in the special cases quoted from Caithness does not affect the possibility in question.

It is equally possible that during the final recession of the ice, at points where the glacier reached the sea, Boulder Clay may have been thrown over shell beds belonging to the most recent period of the Glacial Epoch.

Regarding these intercalated beds, it has also to be determined whether they occupy their peculiar position naturally or accidentally.

The Boulder Clay (as has already been described) exists in great undulating ridges, as well as against hillsides and in the interstices of broken ground, and often rises up in hillocks and eminences, and has marine shell clay deposited in its hollows.

It is clearly within the range of possibility that it should in some instances have been undermined by the action of water or some other physical agency, and have *fallen over* a shell bed of far later date than itself.

In the series of sands, gravels, and clays claimed by Mr. J. Geikie as "interglacial," and regarded by him, in his striking argument, as proving that many changes of climate may have taken place during the accumulation of the Till and its associated deposits, few of a fossiliferous character can as yet be quoted, so that a general discussion of them does not fall within the limits of this paper.

We shall notice only those examined for Ostracoda.

### 1. CROFTHEAD, NEAR GLASGOW.

In the cutting of the Crofthead and Kilmarnock railway, beds of freshwater clay were exposed which have been the subject of considerable discussion. They were described by Mr. J. Geikie as *interglacial*, in the 'Geological Magazine' (vol. v, p. 393, vi 73, vii 53), and as resting upon and covered by the "Till" (Boulder Clay). Mr. Craig in the same magazine questioned whether the upper bed overlying the stratified bed was "a deposit from land ice," and regarded the position of a large mass of Boulder Clay which covered a part of the stratified clay as owing to "a series of slips."<sup>1</sup>

These stratified lacustrine clays yielded the skull and horn core of *Bos primigenius*, part of the horn of *Megaceros Hibernicus*, and a few bones of *Equus caballus*.

<sup>1</sup> See also paper on "The Section of the Crofthead and Kilmarnock Railway." By Robert Craig. 'Trans. Geol. Soc.,' Glasgow, vol. iv, p. 17.

The following Ostracoda were found :

- Cypris virens* (Jurine).
- *cinerea*, Brady.
- *gibba*, Ramdohr.
- Potamocypris fulva*, Brady.
- Candona lactea*, Baird.
- *albicans*, Brady.
- Limnocythere inopinata* (Baird).
- *antiqua*, n. sp.
- Cytheridea lacustris*, G. O. Sars.
- *torosa* (Jones).

## 2. PAISLEY.

When digging a foundation on the side of Oakshaw Hill, on which part of Paisley is built, a hill which is at its summit 106 feet above the sea-level, and stretches in a gradual slope 800 yards from east to west, a bed of Boulder Clay was laid bare, beneath which was found the common Arctic shell of the district "with a bed of *Mytilus edulis* on its surface." This Arctic-shell-clay itself, throughout the whole neighbourhood, rests upon the Boulder Clay. The Rev. W. Fraser (from whose description we quote)<sup>1</sup> states that "this shell-bed was sixty-four feet above the mean sea-level, and the height rising over it was forty-two feet, of what in ordinary circumstances would have been accepted as genuine Till or old Boulder Clay," and attributes its position to the stranding of masses of ice-carrying portions of the Boulder Clay on the ridge.

Mr. J. Young, however, suggests that the position of this Upper Boulder Clay is due either to diggings from the Lower Boulder Clay which have been removed and laid down over more recent deposits, or to a slip of the Boulder Clay forming the crown of the hill over more recent beds.<sup>2</sup>

This shell-clay, although intercalated in the way described, contains precisely the same fauna as that which will be presently given from the Paisley district.

<sup>1</sup> 'Trans. Geol. Soc. of Glasgow,' vol. iv, p. 180.

<sup>2</sup> Ibid., p. 214.

III. *The first great series of fossiliferous Post-Tertiary clays, sands, and gravels is characterised by a fauna of a more or less decidedly Arctic character.*

These clays, sands, and gravels are found in the following positions :

- (1) They exist, in the manner already described, beneath great masses of Boulder Clay.
- (2) They are intercalated, as also has been described, with masses of Boulder Clay.
- (3) They either immediately overlie the fossiliferous Boulder Clay or are separated from it only by a thin seam of laminated clay, but are not covered by Boulder Clay.
- (4) They are connected with a series of sands and gravels.

Examples of Arctic fossiliferous clays beneath the Boulder Clay and intercalated with Boulder Clay have already been discussed ; and we proceed to consider the deposits which are Arctic in character, but are neither situated beneath the Boulder Clay nor intercalated with it.

IV. *A large class of the clays and sands, characterised by an Arctic fauna, in many cases either immediately overlie the unfossiliferous Boulder Clay, or are only separated from it by a thin seam of laminated clay, but are not covered by the Boulder Clay itself.*

These beds belong to the period or periods during which an Arctic fauna was most abundantly developed. Whether they consist of clay, sand, or gravel, is, of course, a circumstance of purely local determination, as it is with the marine deposits which are forming at the present day, but since such differences naturally influenced the fauna of which they were the habitat we shall give some details regarding them, as we notice the localities from which our specimens have been obtained.

As fossiliferous deposits they are generally remarkable for the perfect preservation of the various species they contain *in situ*. At Paisley, *e.g.*, *Cyprina Islandica* occurs with both valves united and covered with its epidermis ; and fragile bivalves like *Nucula tenuis*, *Axinus flexuosus*, var. *Gouldii*, as well as the most delicate Ostracoda, are in a perfect condition. From a clay bed near Blairmore, Loch Long, we have gathered numerous specimens of *Astarte*, including *A. borealis*, *A. sulcata*, *A. compressa*, evidently in their native habitat. In the banks of a freshwater stream near Loch Gilp, a whole bed of *Mya Uddevallensis* was found, each shell in its natural boring position.

*Pecten Islandicus* and *Saxicava* (*Panopæa*) *Norvegica* and *Mya Uddevallensis* have all been collected, in the Kyles of Bute, in the positions in which they lived and died ; the

*Pecten Islandicus* being often covered with large *Balani*, which must have been broken had they been drifted.

In exposed situations there must have been contemporaneous beds of gravel in which the Mollusca were rolled and broken and Ostracoda could not live. An example may be seen in the railway-cutting near Drymen, Stirlingshire (140 feet above the sea), where a gravel bed has been exposed, full of hinges and fragments of the shell of *Cyprina Islandica*, fragments of *Pecten Islandicus*, *Astarte sulcata*, *Buccinum undatum*, and other bivalves, while only a few univalves, like *Trophon clathratus*, are entire, and Entomostraca are very scarce.

Very frequently these Arctic Post-tertiary clays, especially in the west of Scotland, rest upon an unfossiliferous Boulder Clay, a thin seam of laminated clay alone interposing, and are overlain by beds of sand and gravel, followed by peat and surface soil.

The Boulder Clay throughout the whole district is violently undulated; and the overlying beds of the Arctic shell clay commonly rest in the hollows of the Boulder Clay, although in some instances, as at Jordan Hill and Airdrie, they attain the heights of 63 feet and 526 feet respectively.

The laminated clay which so frequently interposes between the Boulder Clay and the clay in which an Arctic marine fauna most abundantly occurs may be clearly seen in this position at Paisley, along the shores of Gareloch and Loch Long, at Kilchattan, and throughout the Kyles of Bute. The Boulder Clay *beneath* it, in all these localities, is uniformly azoic, while the clay immediately above it is literally packed with Arctic Mollusca and swarms with Ostracoda.

This laminated clay was formerly supposed to be unfossiliferous; we have, however, detected in it several species of Foraminifera and Ostracoda. When the specimens are extremely rare, it generally happens that they consist of Foraminifera only, but when they prevail to any slight extent Ostracoda are also found.

This laminated clay was probably deposited by the cold and rapid waters of streams issuing from beneath the snow and ice of an elevated land surface, and carrying to the sea the fine mud with which they were charged.

The way in which it has happened that the laminated clay itself contains so few fossils, while the clay immediately above it abounds with Ostracoda and Mollusca, is explained by observations made in the Arctic regions by Dr. Robert Brown, of Campster.<sup>1</sup>

Dr. Brown has had large opportunities of examining ice-action, and draws the distinction between the "ordinary stratified azoic clay and the finer stratified fossiliferous clay," upon which we have been led by our study of the Scotch beds to insist; while he

<sup>1</sup> "On the Physics of Arctic Ice, as explanatory of the Glacial Remains in Scotland." By Robert Brown, of Campster, M.A., Ph.D., F.R.G.S., &c. 'Quarterly Journal of Geological Society,' 1871, vol. xxvi, p. 671.

expresses a strong opinion "regarding the identical character of the sub-glacial stream-clay, and the fossiliferous brick-clay."

"In this clayey bed the Arctic Mollusca and other marine animals find a congenial home, and burrow into it in great numbers. However, as the new deposits are thrown down, they keep near the surface to be able to get their food; so that if to-day a catastrophe were to overwhelm the whole marine life of the Arctic regions, it would be found (supposing by upheaval or otherwise we were able to verify the fact) that the animals would only be imbedded in the upper strata of clay, and that the bottom one, with the exception of a few dead shells, would be azoic; yet I need not say how erroneously we should argue, if, from this, we drew the inference that at the time the bottom layers or strata of this laminated clay were formed there was no life in the Arctic waters, and that they were formed under circumstances which prevented their being fossiliferous. The bearing of this on the subject in question need scarcely be pointed out. It ought to be noted that, supposing we were able to examine the bottom of the Arctic Sea (Davis' Straits, for instance), it would be found that this clayey deposit would not be found over the whole surface of it, but only over patches. For instance, all of the ice-fjords would be found full of it to the depth of many feet, shoaling off at the seaward end; and certain other places on the coast would be also covered with it; but the middle and mouth of Davis' Straits and Baffin's Bay, and the wide intervals between the different ice-fjords, would either be bare or but slightly covered with small patches from local glaciers; yet we should reason most grievously in error did we conclude therefrom that the other portions of the bottom covered with sand, gravel, or black mud were laid down at a different period from the other, or under other different conditions than geographical position. These ice-rivers seem, in the first place, to have taken their direction according to the nature of the country over which the inland ice lies, and latterly according to the course of the glaciers. No doubt they branch over the whole country, like a regular river-system. When the glacier reaches the sea, the stream flows out under the water, and, owing to the smaller specific gravity of the fresh water, rises to the surface, as Dr. Rink describes, 'like springs,' though I do not suppose that he considers (as some have supposed him to do) that that water was in reality spring-water, or of the nature of springs. *Here are generally swarms of Entomostraca and other marine animals, which attract flights of gulls, which are ever noisily fighting for their food in the vicinity of such places*" (p. 682-4).

It is very noticeable that the same kind of laminated clay occupies precisely the same position in the series of glacial beds exposed near Christiania.<sup>1</sup>

We observed the following section at the Lower Foss Clay Bank, near Christiania.

1. Unfossiliferous boulder-clay (with striated blocks, hard and compact).

<sup>1</sup> See 'Notes on the Post-Tertiary Geology of Norway.' By H. W. Crosskey and D. Robertson. 'Trans. Phil. Soc. of Glasgow,' 1868.

2. Laminated clay (not to be distinguished physically from the laminated clay of the Paisley and other sections).

3. Clay, charged with an Arctic fauna.

Just as the district around Paisley and other points where the laminated clay occurs would, from their natural position, receive a body of fresh water, supposing the land during the Glacial Epoch more elevated than at present; so would the district near Christiania, at which the same laminated clay is found.

Whatever its origin, it constitutes a curiously distinct deposit; and is easily distinguishable from the fine clay (sometimes itself called "fine laminated clay" or "glacial marine bed") which succeeds it, and represents the slightly more recent bed of an arctic sea, crowded with life.

The following Ostracoda have been found in the laminated clay:

*Cytheridea punctillata*, Brady.

*Cytherura Sarsii*, Brady.

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### § III. OSTRACODIFEROUS BEDS.

A.—We proceed to notice in detail *the principal beds of clay and sand, characterised by an Arctic Fauna*, from which the Ostracoda described in this Monograph have been derived.

#### 1. PAISLEY.

In studying various clay-pits exposed from time to time in the neighbourhood of Paisley, we have observed the following beds, the measurements of which varied even within a few hundred yards.

The Boulder Clay is of the usual irregular character, rising up in hillocks here and there, to and above the ordinary surface-level; and in some places formed into troughs of considerable depths.

1. Surface soil.
2. Sands and gravels (probably old river-drift).
3. Littoral marine shell bed, containing *Cardium edule*, *Mytilus edulis*, and pieces of wood bored by *Teredo*, &c. (In one section which we measured this bed was nine inches in depth.)
4. Marine fossiliferous clay:
  - a. Upper part; no Mollusca to be found, but Foraminifera and Ostracoda.
  - b. Middle part; a few Mollusca, Ostracoda and Foraminifera more plentiful.
  - c. Lower part; fauna abundant.

5. Laminated clay (estuarine or marine), as a rule, only containing a few Foraminifera.

6. Unfossiliferous Boulder Clay.

An instance in which the fossiliferous clay has been found between two Boulder Clays has been already noted.

We examined in detail the following section at Short Road Brickwork (south side of road).

- |   |                                |
|---|--------------------------------|
| 1. Mould  | 3 to 4 ft.                     |
| 2. Gravel (no fossils)  | $\frac{1}{2}$ upwards to 1 ft. |
| 3. Thick dark clay (fossiliferous, especially in the lower 6 ft.) | 13 ft.                         |
| 4. Laminated whitish clay (with Foraminifera)                     | $1\frac{1}{2}$ ft.             |
| 5. Yellowish-brown clay (with Foraminifera)                       | 2 ft.                          |
| 6. Muddy sand, not cut through (Foraminifera and Ostracoda).      |                                |

The Boulder Clay is met with at about the same level in a pit not more than 100 yards distant, and without doubt forms here, as throughout the district, the base of the series. The first seven feet under the gravel is brownish coloured, especially towards the top, and contains comparatively few fossils. Among these *Mytilus modiolus* is found with united valves. The next six feet run into a dark-grey clay with an abundant fauna. In the tenth and eleventh feet below the gravel is a bed of *Cyprina Islandica*.

The layer of laminated whitish clay (4) under this is more sharply defined below than above. When dry it has little cohesion and breaks down easily between the fingers like a piece of chalk. It is finely laminated, and washes almost wholly away through a sieve of ninety-six meshes to the linear inch. In washing 100 oz. of dry clay, only two drachms were left as a residue, which consisted of very fine sand and a considerable number of *Polystomella striato-punctata* and *Nonionina depressula*.

The yellowish-brown clay (5), constituting the next two feet in the section, is much more cohesive; the layers are divided from an inch to half an inch apart by fine sand; and these again into excessively thin layers by lighter and darker coloured clays. In washing, this is similar to the clay above it, and only one Foraminifer was met with. The muddy sand (6) underlying this loses 63 per cent. in washing; but the greater part of the loss is an extremely fine sand. Three Foraminifera were met with, and one valve of *Cytheridea punctillata*.

The fossils in the clay beds around Paisley are mostly confined, as in the section we have now described, to the lower half of the deposit, and generally have their chief abundance within from one to three feet of the laminated clay.

Foraminifera and Ostracoda are met with, more or less, from top to bottom of the clay, more constantly Foraminifera; but as a rule both are found most profusely where Mollusca prevail. In many cases *Mytilus edulis* occurs in considerable abundance below

*Cyprina islandica*, and near the bottom of the section. This is pre-eminently the case in a clay pit west of Paisley, and at Jordan Hill, about three miles north-west of Glasgow, where it is found fourteen feet below the surface.

The position of the fossils in the clay is not precisely the same in all the glacial beds of the same geological horizon.

When the Greenock New Docks were excavated the laminated clay was cut through for many feet, until the unstratified Boulder Clay was reached; and the junction was sharply marked by a thin layer of whitish-coloured clay, three or four inches thick, containing Foraminifera and Ostracoda. This thin stratum of whitish clay was followed by a darker coloured clay crowded with Mollusca, amongst which were *Cyprina Islandica*, *Pecten Islandicus*, and *Tellina calcarea*.

At Kilchattan tile-works, Buteshire, the fossils of all species are most plentiful, above the laminated clay, in a bed of sand or gravelly sand, which lies between the clays and the upper gravel.

At Elie, Fifeshire, the fossils are plentiful near the top of the clay a little under the gravel, and amongst them are *Leda arctica* and *Thracia myopsis*, with Ostracoda of an extremely arctic character.

In many other deposits of the same age an odd shell is only seen occasionally. This not unfrequently happens at different points of the Paisley beds. In a brickfield on the west side of the Cart, near the park, one or two specimens only by diligent search may be met with, although they are plentiful in cuttings close to the spot.

Before a microscopic examination of the clays was made the fossiliferous beds under discussion were described as situated between an unfossiliferous upper clay and an equally unfossiliferous laminated clay. It will be seen from the foregoing observations, however, that they occupy no such position. Foraminifera and Ostracoda of marine and estuarine character occur in the laminated clay, where the Mollusca are either absent or rare, and continue throughout the upper clay, where the Mollusca gradually disappear.

It thus appears possible to trace by these fossiliferous beds, occurring in the valley of the Clyde, (1) the pouring down of the muddy waters of an arctic river, (2) the subsidence of the land to a depth sufficient for the abode of an arctic fauna in the waters, (3) the gradual disappearance of the marine fauna owing to the re-elevation of the land, (4) the recurring of a river, with far broader boundaries than now exist.

The height above the sea of the arctic-shell-clays around Paisley (including the bed on the higher ground, covered with Boulder Clay, which has been previously described) is from twenty feet to sixty-four feet.

The following Ostracoda have been found :

*Argillæcia cylindrica*, G. O. Sars.

*Pontocypris mytiloides* (Norman).



## POST-TERTIARY ENTOMOSTRACA.

*Pontocypris trigonella*, G. O. Sars.

*Cythere pellucida*, Baird.

— *castanea*, G. O. Sars.

— *crispata*, Brady.

— *viridis*, Müller.

— *lutea*, Müller.

— *globulifera*, Brady.

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *convexa*, Baird.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *costata*, Brady.

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Eucythere Argus* (G. O. Sars).

*Loxoconcha tamarindus* (Jones).

— *fragilis*, G. O. Sars.

*Xestoleberis depressa*, G. O. Sars.

*Cytherura concentrica*, n. sp.

— *undata*, G. O. Sars.

— *Sarsii*, Brady.

— *clathrata*, G. O. Sars.

*Cytheropteron latissimum* (Norman).

*Bythocythere simplex* (Norman).

*Sclerochilus contortus* (Norman).

*Paradoxostoma variabile* (Baird).

*Polycope orbicularis*, G. O. Sars.

*Bosquetia robusta*, nov. gen. et sp.

## 2. IN AND AROUND GLASGOW.

In the immediate neighbourhood of Glasgow the arctic marine clay rests upon a thick bed of sand, and is distinctly covered by a river-drift.<sup>1</sup>

<sup>1</sup> On this and other connected points, see an admirable series of papers by Mr. James Binnie, on "The Surface Geology of Glasgow," published in the 'Trans. Geol. Soc. of Glasgow,' vol. ii, parts ii and iii; vol. iii, part i.

In sections made during the formation of Windmillcroft Dock, Mr. J. Binnie discovered in the Upper Sands, extending from a few feet to a depth of twenty-two feet, numerous portions of the epidermis of *Unio margaritifera*. "A few of them," he writes, "had belonged to single valves, and in one or two instances the epidermis of both valves was flattened together; but the greater number were *lying in their natural position with the umbonal portion undermost, proving that they had lived and died in the gravel and had not been drifted down by a spate.*"<sup>1</sup>

A bed of clay containing marine Ostracoda, together with such arctic Mollusca as *Leda pernula* and *Tellina calcarea*, succeeded this river-drift, and was found to rest upon a bed of white sand of considerable thickness and extent (not exhausted in nineteen feet of dredging between the piles at the entrance of the dock), and containing some polished and striated boulders. Mr. J. Binnie quotes the "Journal of a Bore for an Artesian Well" made at McPhail Street, Greenhead :<sup>2</sup>

|                                    |   |   |   |   |              |
|------------------------------------|---|---|---|---|--------------|
| Surface soil                       | . | . | . | . | 5 ft. 0 in.  |
| Coarse sand                        | . | . | . | . | 1 6          |
| Clay mixed with sand               | . | . | . | . | 2 0          |
| Coarse sand                        | . | . | . | . | 2 6          |
| <hr/>                              |   |   |   |   |              |
| River-drift                        | . | . | . | . | 11 ft. 0 in. |
| Good clay                          | . | . | . | . | 8 0          |
| Muddy clay                         | . | . | . | . | 30 0         |
| <hr/>                              |   |   |   |   |              |
| Marine clay                        | . | . | . | . | 38 0         |
| Soft running sand with gravel      | . | . | . | . | 51 0         |
| Whinstone block                    | . | . | . | . | 2 4          |
| Sand and gravel                    | . | . | . | . | 7 0          |
| Sandstone block                    | . | . | . | . | 0 5½         |
| Sand and gravel                    | . | . | . | . | 1 0          |
| <hr/>                              |   |   |   |   |              |
| White sand series, probably marine | . | . | . | . | 61 9½        |
| <hr/>                              |   |   |   |   |              |
| 110 ft. 9½ in.                     |   |   |   |   |              |

Over a large district, around Glasgow, and connected both with the ancient course of the Clyde and the probable flow of glacial rivers during the period of the elevation of the land, the deposition of the Boulder Clay (similar in character to that upon which the Paisley shell-beds rest, and which crowns eminences such as Garnet Hill

<sup>1</sup> 'Trans. Geol. Soc. of Glasgow,' vol. ii, part ii, p. 109.

<sup>2</sup> Ibid., part iii, p. 265.

and the New Park) appears to have been broken under circumstances which led to the intercalation of numerous beds of sand, gravel, and clay. Two bores may be quoted as examples:<sup>1</sup>

*Blairhardie, No. 4 Pit.*

|                                      |   |   |   |   |   |             |
|--------------------------------------|---|---|---|---|---|-------------|
| Surface soil                         | . | . | . | . | . | 4 ft. 6 in. |
| Blue clay                            | . | . | . | . | . | 9 0         |
| Hard stony clay                      | . | . | . | . | . | 69 0        |
| Sand with a few shells               | . | . | . | . | . | 3 0         |
| Stony clay with boulders             | . | . | . | . | . | 46 6        |
| Mud and running sand                 | . | . | . | . | . | 11 0        |
| Hard clay, boulders, and broken rock | . | . | . | . | . | 27 0        |
|                                      |   |   |   |   |   | <hr/>       |
|                                      |   |   |   |   |   | 170 0       |

*Millichin, two miles east of Garscadden.*

|                                |   |   |   |   |   |             |
|--------------------------------|---|---|---|---|---|-------------|
| Sandy clay                     | . | . | . | . | . | 5 ft. 0 in. |
| Brown clay and stones          | . | . | . | . | . | 17 0        |
| Mud                            | . | . | . | . | . | 15 0        |
| Sandy mud                      | . | . | . | . | . | 31 0        |
| Sand and gravel with water     | . | . | . | . | . | 28 0        |
| Sandy clay and gravel          | . | . | . | . | . | 17 0        |
| Sand                           | . | . | . | . | . | 5 0         |
| Mud                            | . | . | . | . | . | 6 0         |
| Sand                           | . | . | . | . | . | 14 0        |
| Gravel                         | . | . | . | . | . | 30 0        |
| Brown sandy clay and stones    | . | . | . | . | . | 30 0        |
| Hard red gravel                | . | . | . | . | . | 4 6         |
| Light mud and sand             | . | . | . | . | . | 1 8         |
| Light clay and stones          | . | . | . | . | . | 6 6         |
| Light clay and whin block      | . | . | . | . | . | 26 0        |
| Fine sandy mud                 | . | . | . | . | . | 36 0        |
| Brown clay, gravel, and stones | . | . | . | . | . | 14 4        |
| Dark clay and stones           | . | . | . | . | . | 68 0        |
|                                |   |   |   |   |   | <hr/>       |
|                                |   |   |   |   |   | 355 0       |

<sup>1</sup> A series of bores is given in detail by Mr. Binnie in 'Trans. Geol. Soc. of Glasgow,' p. 133, vol. iii, part i.

Mr. Binnie sums up the general results as follows :—" Between fifty and sixty bores have been obtained having sand, gravel, or clay, true water-drifted materials, interstratified with or lying beneath Boulder Clay. Twenty-five of these have one bed of sand or clay intercalated between two beds of Boulder Clay, proving that one break occurred. Ten bores have two beds of sand or clay intercalated between three beds of Boulder Clay; showing, of course, so many more breaks. One bore has three, and two bores have four beds of sand, interpolated in Boulder Clay; while one bore has no less than five beds of sand alternating with Boulder Clay,—a number sufficient to prove that the ice-sheet was not continuous throughout the Glacial Epoch, but disappeared for periods so long that great beds of water-made *débris* could be deposited in the interval. Twenty bores have sand or gravel at the bottom and Boulder Clay above. Some of these may possibly be preglacial and synchronous with the Crag period of England, but they are probably interglacial, and only apparently preglacial from accidental causes easily supposable."<sup>1</sup>

It must be remembered, however, that the district covered by these bores would probably be more or less directly connected with the bed of a glacial river, debouching into the sea, and be peculiarly affected, therefore, by the summer meltings of the ice. A large part of it also has undoubtedly been covered by floating ice charged with *débris* during the later portions of the Glacial Epoch.

At Windmillcroft, sixteen feet above the sea, the following Ostracoda have been found :

*Sclerochilus contortus* (Norman).

*Cytheropteron latissimum* (Norman).

### 3. STOBXCROSS RAILWAY-CUTTING (GLASGOW).

In this cutting a section nearly half a mile in length is exposed, between Galbraith Street on the east and Sandyford Street on the west, to a depth of forty feet from the surface.

At the west end it passes through a layer of Boulder Clay 300 yards in length and 37 feet at its highest summit. On the east, where the knoll dips more rapidly than on the west, it is overlapped by a fine yellow sand, which, after continuing a little further eastward, is replaced by gravel.

On the north side of the cutting a series of sands, clays, and gravels abuts against the Boulder Clay, and stretches over it. The sand overlies the gravel, which is covered with the clay, and the clay at some points is overlain by sand. There is no definite order, however, in which the sands, gravels, and clays of this neighbourhood fixedly

<sup>1</sup> Ibid., p. 136.

recur, although the bores show that in some places sand alternates with gravel to a depth of eighty or ninety feet.

The layers exposed in the railway-cutting do not maintain a horizontal line or follow a regular dip, but present false beddings with violent contortions.

The overlying shell-bearing clays conform, however, to the sand banks over which they are deposited, with depressions less or more abrupt according to their character. The shell-bearing clays of this section are therefore evidently of later date than the estuarine sands upon which they rest, as well as later than the Boulder Clay.

The clay is for the most part of a sandy character ; it is finest towards the east, where it is deepest and overlapped with muddy sand, with which it is less and less mixed as it descends.

Along the north of the cutting, where the clay is seen overlying the sand, many of the layers of sand are more or less mixed with mud, showing that the deposit of mud has gone on mixing with the sand until changed circumstances permitted the mud to accumulate.

The divisions between the layers of clay are, in most instances, formed by a very fine sprinkling of fine sand, and groups of these layers are often again divided by thicker and coarser beds of sand.

These groups of thin layers are sometimes nearly of the same depth, but at other times are more irregular, and the bands of sand vary in thickness.

These very thin layers appear to have been formed by frequent and gentle undulations of the water. Winds and tides would carry over the mud only the finest particles of sand, while the thicker bands would be produced by stronger winds and storms. The lapse of time between the recurrence of these disturbing causes may be reckoned by the distance of the bands from each other, and their strength by the depth of the bands.

From the sharp lines between the bands we may infer that the causes were transient ; but in the case of such deposits as those at Stobcross, where the sands and clays have been washed into each other, the conditions must have been more continuous and the water comparatively shallow.

The fauna (which has been chiefly obtained from the east bank of clay), although not abundant, furnishes ample proof of the purely marine character of the deposit. Among the shells obtained were—

*Tellina calcarea*,  
*Cyprina Islandica*,  
*Mya truncata*, &c.

In the muddy sand exposed at a lower level in the excavation for the Stobcross Docks, close by the Clyde, *brackish* water Ostracoda are found, marking the change from a sea to an estuary.

The following Ostracoda were found :

- Cythere pellucida*, Baird.
- *porcellanea*, Brady.
- *viridis*, Müller.
- *limicola* (Norman).
- *villosa* (G. O. Sars).
- *concinna*, Jones.
- *Dunelmensis* (Norman).
- Cytheridea papillosa*, Bosquet.
- *punctillata*, Brady.
- Cytherura nigrescens* (Baird).

#### 4. JORDAN HILL, NEAR GLASGOW.

The Crow Road, on the side of which the clay is worked, is at that point sixty-three feet above the sea-level.

The clay extends down the incline of the hill, approaching the valley of the Clyde, on the south, where it is exposed along the White Inch Railway, and also passes over its summit on the north.

Jordan Hill itself is irregularly covered with masses of Boulder Clay of variable thickness ; the Boulder Clay, however, cannot be observed in any place to rest upon the shell-beds.

Our examination of one series of excavations, made to a depth of from twelve to twenty-four feet, established the existence of the following series of beds ; their thicknesses, as usual, varying over very narrow areas.

- |  |              |
|--|--------------|
| 1. Surface soil . . . . .  | 1 to 2 ft.   |
| 2. Reddish-brown clay (unfossiliferous) . . . . .  | 7 to 8 ft.   |
| 3. Dark grey or blue clay (arctic-shell-bed) . . . . .   | 10 to 14 ft. |
| 4. Laminated clay or mud (not excavated because unfit for brick unless mixed with other clays) . . . . . |              |

The reddish-brown clay (2) is full of vertical fractures, whose sides have a bluish colour, and are generally so smooth as to present the aspect of *slickensides*.

The laminated clay is friable, marked by exceedingly thin laminations, and is the

same as that which we have already described as underlying the clay more abundantly charged with the arctic fauna of the district, although itself containing evidence of its marine origin. The Boulder Clay can be traced to points at which it evidently passes under the whole series of laminated and fossiliferous clays.

At another point of the Hill two distinct fossiliferous beds can be traced, and the series runs :

1. Surface soil.
2. Littoral shell-bed a few inches (with *Littorina litorea*, *L. rudis*, *Mytilus edulis*, &c., all recent species).
3. Clay with arctic species ; chiefly confined to a band of two to three feet.
4. Laminated clay.

A similar littoral shell-bed (2) is met with on the low ground on the north of Paisley, about fifty feet lower than Jordan Hill.

*The two tidal belts represented by these littoral shell-beds could not have been coexistent.*

Another curious feature in this deposit is the position of the Mussel-bed. While *Mytilus edulis* certainly abounds in the youngest littoral beds, it is also found at greater depths and overlain by arctic shells.

At Paisley it is found twelve feet below the surface, at Muirhouse nineteen feet, at Stobcross twenty-four feet, and at Jordan Hill fourteen feet.

Mussel-beds undoubtedly existed, therefore, in the early periods of the deposition of the arctic clays as well as in the most recent, indicating several changes of level in the sea-bottom, and marking in the various heights at which they occur changes of elevation in the land-surface.

Height above the sea, sixty-three feet.

The following Ostracoda were found :

- Cythere pellucida*, Baird.  
— *castanea*, G. O. Sars.  
— *deflexa*, nov. sp.  
— *viridis*, Müller.  
— *lutea*, Müller.  
— *villosa* (G. O. Sars).  
— *pulchella*, Brady.

- Cythere concinna*, Jones.<sup>1</sup>  
 — *Dunelmensis* (Norman).  
*Cytheridea papillosa*, Bosquet.  
 — *punctillata*, Brady.  
*Cytherura nigrescens* (Baird).  
 — *undata*, G. O. Sars.  
 — *gibba* (Müller).  
 — *cellulosa* (Norman).  
 — *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
*Bythocythere simplex* (Norman).  
*Sclerochilus contortus* (Norman).

5. GOVAN.

In the excavations for Messrs. Randolph and Elder's docks two beds of clay were exposed.

1. The upper bed was composed of sand, gravel, and sandy mud, and dipped towards the Clyde. The section was—

|   |       |
|---|-------|
| a. Mould  | 4 ft. |
| b. Black vegetable matter, crowded with leaves, fragments of twigs, &c. | 1     |
| c. Gravel and sand alternating  | 4     |
| d. Muddy sand (not pierced through)                                     |       |

In the muddy sand *Pecten opercularis* and *Trochus cinerarius* were met with.

2. The lower bed was not detected in the section immediately beneath the upper, but made its appearance at a little distance, dipping away from the river and then rising upwards. At a depth of eighteen feet marine shells were sparingly collected, including

*Cyprina Islandica*,  
*Tellina calcarea*,  
*Mytilus edulis*,  
*Buccinum undatum*,  
*Balanus crenatus*.

The Ostracoda from this lower bed proved precisely the same as those common in the

<sup>1</sup> The remains of the limbs are distinctly visible in some specimens of this species from this bed.



fossiliferous glacial beds of the west of Scotland, with the exception of *Loxoconcha elliptica*, a brackish water form, which was probably washed into it from the upper mud.

In the lower clay the following Ostracoda were found.

- Cythere castanea*, G. O. Sars.
- *viridis*, Müller.
- *Clutha*, n. sp.
- *globulifera*, Brady.
- *villosa* (G. O. Sars).
- *concinna*, Jones.
- *Dunelmensis* (Norman).
- Cytheridea punctillata*, Brady.
- Loxoconcha elliptica*, Brady.
- Cytherura nigrescens* (Baird).
- *undata*, G. O. Sars.
- Cytheropteron latissimum* (Norman).
- *Montrosiense*, n. sp.
- *elongatum*, n. sp.
- Bythocythere simplex* (Norman).
- *constricta*, G. O. Sars.
- Sclerochilus contortus* (Norman).
- Paradoxostoma variabile* (Baird).
- Polycope orbicularis*, G. O. Sars.

#### 6. ROWAN BRIDGE, GLASGOW AND PAISLEY CANAL.

The shell-clay appears about 100 yards to the west of this bridge. The clay is of a grey colour, and when dry consists of 89 per cent. fine mud, and 11 per cent. *débris* of shells, with gravel and sand. *Mytilus edulis* is abundant, and is associated with *Tellina calcarea*, and the usual species belonging to the arctic clays.

Height above the sea forty-six feet.

The following Ostracoda were found :

- Cythere pellucida*, Baird.
- *viridis*, Müller.

- Cythere lutea*, Müller.  
 — *villosa* (G. O. Sars).  
 — *concinna*, Jones.  
 — *Dunelmensis* (Norman).  
*Cytheridea punctillata*, Brady.  
*Cytherura nigrescens* (Baird).  
 — *undata*, G. O. Sars.

## 7. OLD MAINS, RENFREW.

In a cutting for a tramway, between the Houston Pit No. 5 and the farm of Old Mains, a bed of shells of arctic character is exposed. The cutting is from six to seven feet at the highest point, and the bed of shells stretches along the section for about twenty yards, cropping out towards the farm and dipping towards the River Cart. The thickest part of the shell-stratum exposed is from eighteen to twenty inches; but the cutting appears only to have touched the edge of the shell-bed, as it is not seen on the opposite bank.

The deposit is made up of brown sand and earth crowded with stones, many of them covered with *Balani*. Sand predominates in the shell-stratum. *Mytilus modiolus*, *Saxicava rugosa*, *Astarte sulcata*, and *Axinus flexuosus* we found with united valves. Such species as *Pecten Islandicus*, *Tellina calcarea*, *Trochus Grænlændicus*, *T. tumidus*, *Natica affinis*, *N. Grænlændica*, *Velutina zonata*, *Pleurotoma violacea*, *Buccinum Grænlændicum*, also occur.

Height above the sea thirty feet.

The following Ostracoda were found :

- Cythere pellucida*, Baird.  
 — *castanea*, G. O. Sars.  
 — *concinna*, Jones.  
 — *viridis*, Müller.  
 — *lutea*, Müller.  
 — *villosa* (G. O. Sars).  
 — *angulata* (G. O. Sars).  
 — *tuberculata* (G. O. Sars).  
 — *Dunelmensis* (Norman).  
*Cytheridea papillosa*, Bosquet.

- Cytheridea punctillata*, Brady.  
*Eucythere Argus* (G. O. Sars).  
*Cytherura nigrescens* (Baird).  
 — *undata*, G. O. Sars.  
 — *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
*Sclerochilus contortus* (Norman).  
*Polycope orbicularis*, G. O. Sars.

## 8. DALMUIR, DUMBARTONSHIRE.

The deposit at Dalmuir was first described by Dr. Thomas Thompson in a paper entitled "On a deposit of Recent Marine Shells at Dalmuir, Dumbartonshire," and published in the 'Records of General Science,' vol. i, p. 133 (1835). At that time, however, the distinction was not drawn between the recent marine shell-beds and the arctic shell-beds, to the latter of which classes the Dalmuir deposit undoubtedly belongs. Dr. Thompson describes the locality as follows:—"The locality in which the fossils are exposed is situated on the banks of the Dalmuir Burn, about 100 yards above the bridge, by which the road from Glasgow to Dumbarton crosses it, and about a mile from the Clyde. The current of the stream is not very rapid, so that the bed of shells is probably not more than twenty feet above the level of the Clyde, which at that place is sensibly salt at high water. The breadth of the channel of the stream at this place is about fourteen feet, and the depth of the banks is about two and a half feet. The sandy deposit appears to extend on both sides of the stream, upwards and downwards, without alteration; but the fossils are confined to a circular or rather elliptical face, the breadth of which (across the stream) is, about twenty-five feet, while its length is only about fifteen feet. The deposit extends back from each bank only about six feet, so that more than one half the whole mass has been cut away during the change of the course of the rivulet . . . . The depth of the bed in its original state must have been twelve or fourteen feet." Mr. Sowerby pronounced three of the species there found to differ from any known recent British species. One of them was said to be *Natica glaucinoides*, a Crag fossil (really, we believe, *N. affinis*, described as *N. clausa* by Searles Wood in 'Monograph of Crag Mollusca,' Part I, p. 147); another was called *Fusus lamellosus*, "which had only been observed about the Straits of Magellan" (a mistake for the arctic species now called *Trophon clathratum*, var. *Gunneri*); and a third, *Buccinum striatum*, "an unknown species" (now identified with *B. Grænlædicum*, Chemnitz).

The fact, however, that these species were unknown as British, led Mr. J. Smith to

imagine that the term "recent," which had been usually applied to such deposits, was not rigidly correct; and he made another excavation and published a list of shells which established the glacial character of the beds.<sup>1</sup>

No further examination of the Dalmuir beds was carried on until we made an excavation in the east side of the stream to the north of the bridge on the Dumbarton Road, in the immediately adjacent field, about half way down. At this point the shells are discovered in great abundance, in the position described by Dr. Thompson, beneath an overlying bed of sand and gravel. Of eleven pounds of the dry clay from this bed three pounds two ounces were lost in washing through a sieve of ninety-six cross threads to the inch, leaving seven pounds fourteen ounces of a residue. Three and a half pounds of this residue were retained in a sieve of  $\frac{1}{8}$ -inch mesh, and consisted chiefly of small stones of trap, quartz, and sandstone; a few were quite smooth and only rounded at the corners, others less or more irregular. Many of the polished stones were fractured, and some few finely striated. The bulk of the shelly *débris* in this portion was made up of *Mytilus edulis* and *M. modiolus*. The other portion of the residue (four pounds six ounces) consisted chiefly of sand, mixed with the plates and spines of *Echini* and many species of small Mollusca.

Besides this north patch of shell-bearing clay, there is another bed a few hundred yards to the south which was laid open by a cutting for the water-course of the Dalmuir paper-mill, and extends along the north side of the bank, about forty yards east of the burn. The shell-bearing clay rises about four feet above the water-course, when it is overlain by two feet of waterworn gravel. The upper portion of the shell-bearing clay is more sandy than the lower, which contains more stones, most of them water-worn, some rounded off at the corners, a few angular, and a few with well-marked striations. Beneath the upper clay, however, is a bed of sand about six inches in thickness, in which many of the peculiarly Arctic Mollusca are especially large and strong. *Trophon clathratum*, e. g., is very abundant, while it is scarce in the upper part of the clay. The sand is followed by a stiff blue Boulder Clay (common through the district) in which no shells occur.

The complete section is, therefore, as follows:

- |                                       |   |   |   |   |                 |
|---------------------------------------|---|---|---|---|-----------------|
| 1. Sand and gravel                    | . | . | . | . | 2½ ft. to 6 ft. |
| 2. Shell-bearing clay                 | . | . | . | . | 2 ft.           |
| <i>a.</i> Upper part mixed with sand. |   |   |   |   |                 |
| <i>b.</i> Lower part not sandy.       |   |   |   |   |                 |
| 3. Shell-bearing sand                 | . | . | . | . | 6 inches.       |
| 4. Boulder Clay, not pierced through. |   |   |   |   |                 |

<sup>1</sup> 'Memoirs of Wernerian Soc.,' vol. viii, p. 50.

In the section on the north, the shell-bearing sandy clay was originally twelve or fourteen feet.

In both beds the deposit of shell-bearing clay appears very circumscribed. It could not be traced for more than twenty yards along the watercourse; and from the point where the shells are exposed, the overlying gravel deepens on both sides east and west.

There can be no doubt, however, that many similar patches of fossiliferous sands and clays exist beneath the surface at different points through the whole district where circumstances have permitted their preservation, and will from time to time be discovered.

Although the fauna of the two beds described is of precisely the same general character, there are local differences in the species found equivalent to those which occur in neighbouring parts of the same sea bottom at the present day. *Tellina calcarea* and *Trophon clathratum*, var. *Gunneri*, e.g., are more common in the south than in the north, but *T. truncatum* and *Lacuna divaricata*, with spines of *Echini*, are much rarer.

Height above the sea thirty-eight feet.

The following Ostracoda were found:

- Potamocypris fulva*, Brady.
- Argillæcia cylindrica*, G. O. Sars.
- Cythere castanea*, G. O. Sars.
- *pellucida*, Baird.
- *porcellanea*, Brady.
- *viridis*, Müller.
- *lutea*, Müller.
- *villosa* (G. O. Sars).
- *concinna*, Jones.
- *angulata* (G. O. Sars).
- *tuberculata* (G. O. Sars).
- *Dunelmensis* (Norman).
- Cytheridea punctillata*, Brady.
- Eucythere Argus* (G. O. Sars).
- Loxoconcha tamarindus* (Jones).
- Cytherura nigrescens* (Baird).
- *similis*, G. O. Sars.
- *pumila*, n. sp.
- *undata*, G. O. Sars.

- Cytherura Sarsii*, Brady.  
 — *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
 — *nodosum*, Brady.  
 — *angulatum*, Brady and Robertson.  
*Bythocythere simplex* (Norman).  
*Pseudocythere caudata*, G. O. Sars.  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma tenerum*, n. sp.  
*Polycope orbicularis*, G. O. Sars.

## 9. DUMBARTON.

A bed of glacial clay was reached in sinking the foundations of a house near the south end of the bridge crossing Leven Water. The same clay appears at half-tide-mark near Cardross, a few feet above high-tide-mark in the bay to the east of Helensburgh, and in patches all along the bay on which Helensburgh stands as far as the spit of gravel at the entrance of Gareloch.

Height above the sea fifteen to eighteen feet.

The following Ostracoda were found :

- Argillæcia cylindrica*, G. O. Sars.  
*Pontocypris mytiloides* (Norman).  
*Cythere castanea*, G. O. Sars.  
 — *viridis*, Müller.  
 — *lutea*, Müller.  
 — *pulchella*, Brady.  
 — *villosa* (G. O. Sars).  
 — *limicola* (Norman).  
 — *angulata* (G. O. Sars).  
 — *concinna*, Jones.  
 — *tuberculata* (G. O. Sars).  
 — *Dunelmensis* (Norman).  
*Cytheridea punctillata*, Brady.  
 — *papillosa*, Bosquet.

- Eucythere Argus* (G. O. Sars).  
*Loxoconcha tamarindus* (Jones).  
*Cytherura similis*, G. O. Sars.  
 — *nigrescens* (Baird).  
 — *undata*, G. O. Sars.  
 — *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
 — *angulatum*, Brady and Robertson.  
*Bythocythere constricta*, G. O. Sars.  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma variabile* (Baird).  
 — *tenerum*, n. sp.  
*Polycope orbicularis*, G. O. Sars.

## 10. LOCH LOMOND.

On the shore of the little island of Inchlonaig, in dry seasons when the water of the lake is very low, a bed of dark grey clay is exposed, thickly interspersed with shells, amongst which are *Tellina calcarea*, *Pecten Islandicus*, *Leda pernula*, *L. pygmæa*, *Trochus Grælandicus*, and *Pleurotoma pyramidalis*, species which sufficiently establish the general arctic character of the deposit.

The same clay has also been found in the banks of a small burn to the north of the Pass of Balmaha.

A shell-bed of a more recent character occurs on the Loch side, in a little creek at Rossaden, near Luss, which must not be confounded with this older arctic clay. It is one to two feet under the ordinary level of the Loch. The clay is of a whitish colour, and has a strong peaty smell. It is very pure, containing only a small percentage of sand. The shells are abundant, but exceedingly friable. *Mytilus edulis* and *Hydrobia ulvæ* are the most abundant; *Littorina* is moderately common; and *Tellina Balthica* is represented by a few valves. All these species can endure a certain admixture of fresh water with the sea. A few Foraminifera occur of similar habitat, but no Ostracoda.

Height above the sea twenty feet.

In the glacial clay of Inchlonaig the following Ostracoda were found :

- Cythere pellucida*, Baird.  
 — *viridis*, Müller.

*Cythere lutea*, Müller.

— *limicola* (Norman).

— *villosa* (G. O. Sars).

— *angulata* (G. O. Sars).

— *concinna*, Jones.

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Loxoconcha tamarindus* (Jones).

*Cytherura nigrescens* (Baird).

— *undata*, G. O. Sars.

— *clathrata*, G. O. Sars.

*Cytheropteron angulatum*, Brady and Robertson.

— *latissimum* (Norman).

## 11. GARVEL PARK NEW DOCK, GREENOCK.

The dock, in the construction of which the fossiliferous deposit was found, runs very nearly parallel with the Clyde, and was cut through a slightly inclined bank of compact Boulder Clay about sixty yards from the shore. The bottom of the section is forty feet beneath the surface. The first ten or fifteen feet are crowded with large boulders, many of them striated on one or more sides. Towards the bottom boulders of large size are fewer, one only being seen here and there; but the clay is closely packed with small pebbles, few of them exceeding an inch in diameter. The great majority of the larger boulders are sandstones from the immediate neighbourhood, the remainder being of quartz, mica-schist, &c., from the Argyleshire mountains to the north-west. The blocks derived from a distance not unfrequently show much cross striation. The Boulder Clay is of such stiff consistence that gunpowder has comparatively small effect upon it.

The deep section of the dock is about 500 feet in length, and the colour of the clay varies, the junction of grey and reddish-brown clays at some points being very decidedly marked both vertically and horizontally. At one place the red clay, in the form of an obtuse inverted cone, reaches nearly to the bottom of the section; and this fact accounts for the irregular position of the red and grey clays as described in the "journal of the bores." The reddish colour of the Boulder Clay is, without doubt, due to a large admixture of the soft Old Red Sandstone of this portion of the coast.



A sample of the red Boulder Clay taken from a depth of fourteen feet consisted of 76 per cent. fine mud, 10 per cent. sand, 14 per cent. gravel or small pebbles.

A sample of the grey Boulder Clay taken from a depth of thirty feet consisted of 56 per cent. fine mud, 9 per cent. sand, 35 per cent. small gravel.

In the upper red Boulder Clay the West Highland rocks, entering into its composition, constitute less than one third, while in the lower division of the grey Boulder Clay at the depth of thirty feet they form more than half of the bulk.

The bores made preparatory to the construction of the dock extended over a radius of about 600 feet, and displayed many irregularities in the succession of the two distinctly marked Boulder Clays.

The following plan and journal of bores will illustrate the disturbed and varying nature of the old Boulder Clay base of many shell-beds.

#### JOURNAL OF BORES AT GARVEL PARK.

|                           | FT. | IN. | FT. | IN. |                            | FT. | IN. | FT. | IN. |
|---------------------------|-----|-----|-----|-----|----------------------------|-----|-----|-----|-----|
| No. 1.                    |     |     |     |     | No. 6 (in River).          |     |     |     |     |
| Soil .....                | 1   | 0   |     |     | Dark sand.....             | 3   | 0   |     |     |
| Light till .....          | 29  | 0   |     |     | Light till .....           | 3   | 0   |     |     |
|                           |     |     | 30  | 0   | Red till .....             | 11  | 0   |     |     |
|                           |     |     |     |     |                            |     |     | 17  | 0   |
| No. 2.                    |     |     |     |     | No. 7 (in River).          |     |     |     |     |
| Soil and sand .....       | 2   | 6   |     |     | Dark sand and shells ..... | 3   | 6   |     |     |
| Light till .....          | 38  | 6   |     |     | Light till .....           | 8   | 0   |     |     |
|                           |     |     | 41  | 0   | Mud .....                  | 1   | 6   |     |     |
| No. 3.                    |     |     |     |     | Red till .....             | 6   | 0   |     |     |
| Soil .....                | 1   | 0   |     |     |                            |     |     | 19  | 0   |
| Sand .....                | 2   | 0   |     |     | No. 8 (in River).          |     |     |     |     |
| Sand and gravel .....     | 5   | 0   |     |     | Sand and shells.....       | 18  | 0   |     |     |
| Light till .....          | 32  | 0   |     |     | Red till .....             | 2   | 0   |     |     |
|                           |     |     | 40  | 0   |                            |     |     | 20  | 0   |
| No. 4.                    |     |     |     |     | No. 9 (in River).          |     |     |     |     |
| Soil .....                | 1   | 0   |     |     | Light till .....           | 4   | 0   |     |     |
| Gravel .....              | 1   | 6   |     |     | Red till .....             | 15  | 0   |     |     |
| Light till .....          | 5   | 6   |     |     |                            |     |     | 19  | 0   |
| Red till .....            | 4   | 0   |     |     | No. 10 (in River).         |     |     |     |     |
| Sandstone rock.....       | 3   | 0   |     |     | Sand and shells.....       | 7   | 6   |     |     |
|                           |     |     | 15  | 0   | Light till .....           | 17  | 6   |     |     |
| No. 5 (in River).         |     |     |     |     |                            |     |     | 25  | 0   |
| Sand .....                | 2   | 0   |     |     | No. 11 (in River).         |     |     |     |     |
| Red till and stones ..... | 6   | 0   |     |     | Sand .....                 | 9   | 0   |     |     |
| Sandstone rock.....       | 1   | 0   |     |     | Light till .....           | 11  | 6   |     |     |
|                           |     |     | 9   | 0   |                            |     |     | 20  | 6   |

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|                            | FT. | IN. | FT. | IN. |
|----------------------------|-----|-----|-----|-----|
| <b>No. 12 (in River).</b>  |     |     |     |     |
| Sand .....                 | 27  | 0   |     |     |
| Light till .....           | 9   | 0   |     |     |
|                            | —   |     | 36  | 0   |
| <b>No. 13 (in River).</b>  |     |     |     |     |
| Light till .....           | 20  | 0   |     |     |
|                            | —   |     | 20  | 0   |
| <b>No. 14 (in River).</b>  |     |     |     |     |
| Light till .....           | 24  | 0   |     |     |
|                            | —   |     | 24  | 0   |
| <b>No. 15 (in River).</b>  |     |     |     |     |
| Dark sandy till .....      | 6   | 0   |     |     |
| Light till .....           | 14  | 0   |     |     |
|                            | —   |     | 20  | 0   |
| <b>No. 16 (in River).</b>  |     |     |     |     |
| Red till .....             | 7   | 6   |     |     |
| Sandstone rock.....        | 2   | 6   |     |     |
|                            | —   |     | 10  | 0   |
| <b>No. 17 (in River).</b>  |     |     |     |     |
| Sand and shells.....       | 4   | 0   |     |     |
| Dark sandy till .....      | 7   | 0   |     |     |
| Red till .....             | 9   | 0   |     |     |
|                            | —   |     | 20  | 0   |
| <b>No. 18 (in River).</b>  |     |     |     |     |
| Dark sandy till .....      | 6   | 0   |     |     |
| Red till .....             | 4   | 0   |     |     |
| Sandstone rock.....        | 1   | 0   |     |     |
|                            | —   |     | 11  | 0   |
| <b>No. 19 (in River).</b>  |     |     |     |     |
| Red till .....             | 6   | 0   |     |     |
| Light till .....           | 13  | 0   |     |     |
| Mud (firm) .....           | 6   | 6   |     |     |
|                            | —   |     | 25  | 6   |
| <b>No. 20.</b>             |     |     |     |     |
| Soil .....                 | 1   | 0   |     |     |
| Silt and shells .....      | 6   | 6   |     |     |
| Light till .....           | 26  | 6   |     |     |
|                            | —   |     | 34  | 0   |
| <b>No. 21.</b>             |     |     |     |     |
| Soil .....                 | 1   | 0   |     |     |
| Light till .....           | 34  | 0   |     |     |
|                            | —   |     | 35  | 0   |
| <b>No. 22 (in River).</b>  |     |     |     |     |
| Light till .....           | 30  | 0   |     |     |
|                            | —   |     | 30  | 0   |
| <b>No. 23 (in River).</b>  |     |     |     |     |
| Light till .....           | 30  | 0   |     |     |
|                            | —   |     | 30  | 0   |
| <b>No. 24 (in River).</b>  |     |     |     |     |
| Light till .....           | 30  | 0   |     |     |
|                            | —   |     | 30  | 0   |
| <b>No. 25.</b>             |     |     |     |     |
| Soil .....                 | 1   | 0   |     |     |
| Gravel .....               | 3   | 0   |     |     |
| Light till .....           | 27  | 0   |     |     |
|                            | —   |     | 31  | 0   |
| <b>No. 26.</b>             |     |     |     |     |
| Soil .....                 | 1   | 0   |     |     |
| Light till .....           | 33  | 0   |     |     |
| Red till .....             | 3   | 0   |     |     |
| Light till .....           | 3   | 0   |     |     |
|                            | —   |     | 40  | 0   |
| <b>No. 27.</b>             |     |     |     |     |
| Soil .....                 | 1   | 0   |     |     |
| Light till .....           | 1   | 6   |     |     |
| Sandstone block .....      | 1   | 0   |     |     |
| Light till .....           | 36  | 6   |     |     |
|                            | —   |     | 40  | 0   |
| <b>No. 28.</b>             |     |     |     |     |
| Soil .....                 | 1   | 0   |     |     |
| Light till .....           | 3   | 0   |     |     |
| Red till .....             | 15  | 6   |     |     |
| Hard white sandstone ..... | 0   | 7   |     |     |
|                            | —   |     | 20  | 1   |
| <b>No. 29.</b>             |     |     |     |     |
| Red till and stones .....  | 4   | 0   |     |     |
| Light till and stones..... | 13  | 0   |     |     |
|                            | —   |     | 17  | 0   |
| <b>No. 30.</b>             |     |     |     |     |
| Red till and stones .....  | 10  | 6   |     |     |
| Light till and stones..... | 13  | 8   |     |     |
| Red till and stones .....  | 5   | 2   |     |     |
| Red sandstone .....        | 3   | 2   |     |     |
|                            | —   |     | 32  | 6   |

|                               | FT. | IN. | FT. | IN. |                              | FT. | IN. | FT. | IN. |
|-------------------------------|-----|-----|-----|-----|------------------------------|-----|-----|-----|-----|
| No. 31.                       |     |     |     |     | No. 4a.                      |     |     |     |     |
| Red till and stones .....     | 8   | 3   |     |     | Soil .....                   | 1   | 0   |     |     |
| Light till and stones.....    | 9   | 0   |     |     | Yellow clay .....            | 5   | 6   |     |     |
| Red sandstone .....           | 6   | 1   |     |     | Grey till.....               | 18  | 0   |     |     |
|                               |     |     | 23  | 4   | Red sandstone .....          | 3   | 6   |     |     |
| No. 32.                       |     |     |     |     |                              |     |     | 28  | 0   |
| Light till .....              | 14  | 7   |     |     | No. 5a.                      |     |     |     |     |
| Fire-clay .....               | 1   | 9   |     |     | Soil .....                   | 0   | 9   |     |     |
| Red sandstone (soft).....     | 4   | 7   |     |     | Yellow clay .....            | 4   | 6   |     |     |
| Red sandstone (hard) .....    | 1   | 5   |     |     | Grey till .....              | 8   | 3   |     |     |
|                               |     |     | 22  | 4   | Red till .....               | 3   | 3   |     |     |
| No. 33.                       |     |     |     |     | Red sandstone .....          | 3   | 2   |     |     |
| Soil .....                    | 1   | 0   |     |     |                              |     |     | 19  | 11  |
| Light till .....              | 34  | 5   |     |     | No. 6a.                      |     |     |     |     |
| Light till, with blocks ..... | 6   | 1   |     |     | Red till and stones .....    | 3   | 9   |     |     |
|                               |     |     | 41  | 6   | Soft white sandstone .....   | 1   | 6   |     |     |
| No. 34.                       |     |     |     |     |                              |     |     | 5   | 3   |
| Soil .....                    | 1   | 0   |     |     | No. 7a.                      |     |     |     |     |
| Light till and stones.....    | 6   | 4   |     |     | Sand and stones .....        | 1   | 6   |     |     |
| Sandstone block .....         | 1   | 6   |     |     | Red till and stones .....    | 4   | 0   |     |     |
| Light till and stones.....    | 2   | 6   |     |     | Darker till and stones ..... | 6   | 0   |     |     |
| Sandstone block .....         | 2   | 3   |     |     |                              |     |     | 11  | 6   |
| Light till and stones.....    | 24  | 4   |     |     | No. 8a.                      |     |     |     |     |
| White sandstone .....         | 0   | 1   |     |     | Light grey till .....        | 1   | 0   |     |     |
|                               |     |     | 38  | 0   | Fine red till .....          | 6   | 6   |     |     |
| No. 35, TRIAL PIT.            |     |     |     |     |                              |     |     | 7   | 6   |
| Soil .....                    | 1   | 0   |     |     |                              |     |     |     |     |
| Yellow clay .....             | 7   | 6   |     |     |                              |     |     |     |     |
| Grey till and stones .....    | 13  | 6   |     |     |                              |     |     |     |     |
| Red till and stones .....     | 3   | 0   |     |     |                              |     |     |     |     |
| Grey till .....               | 2   | 0   |     |     |                              |     |     |     |     |
| White sandstone .....         | 0   | 11  |     |     |                              |     |     |     |     |
|                               |     |     | 27  | 11  |                              |     |     |     |     |

Looking at these forty bores, and confining ourselves to the clays only, which vary from nine to thirty-eight feet in thickness—in nineteen of these what is termed “light till” (*grey unstratified clay*) is only met with. In six bores what is termed red till (*reddish unstratified clay*) is only met with. In other six both occur, and the light-coloured till overlies the red. In three the red overlies the light, while in the remaining six the clays alternate variously. For example, taking them in the ascending order, in one bore, No. 26, light till, three feet; red till, three feet; light till, thirty-three feet. In another, No. 30, red till, five feet; light till, thirteen feet; red till, ten feet.

Three of the bores, lying between the dock and the highway, have the addition of what is termed yellow clay. Taking them in the same order as above, No. 35 has light till, two feet; red till, three feet; light till, thirteen feet; yellow till, seven feet.

In another, No. 4a, light till, eighteen feet ; yellow clay, five feet. Again, in No. 5a, red till, three feet ; grey till, five feet ; yellow till, four feet.

In all these bores, some of which extend two hundred feet beyond low water, the same varieties of Boulder Clay have been met with in varying proportions.

In bore No. 8, sixty yards beyond low water, eighteen feet of sand and shells overlie the red till ; but we cannot learn whether the shells belong to the glacial or recent period.

About the same distance beyond low water, No. 12, twenty-seven feet of sand overlies light till ; another bore, about half-way between this and low water, No. 13, gives twenty feet light till.

The fossiliferous clay lies in a trough or oblong hollow in the Boulder Clay, crossing the longitudinal section of the dock, and shallowing at both ends. On the south it terminates near the surface about two hundred yards west of Garvel Park House, and on the north, at the embankment near the surface, close to the Clyde.

The length of the trough is about three hundred feet, its breadth twenty-four feet, and its depth, near the middle, fourteen feet. This trough is filled with a remarkable fossiliferous clay, crowded with Post-tertiary Mollusca and other marine organisms, which, like those found in other "Clyde beds," are of arctic type.

The natural character of this deposit was at first suspected because of (1) the disorderly manner in which the shells are distributed, and (2) the soft loose state of the clay in which they are embedded, which resembles material that has been roughly drifted rather than regularly deposited. We have come, however, to the conclusion that these shells lived and died where they are now found.

With regard to the apparent disorder in which they lay, it is well known that where Mollusca congregate, dead shells often preponderate largely over the living ; and that a great number of the shells in this deposit were accumulated as dead shells is evident from the numerous valves having their internal surfaces grown over with marine organisms. Although, on a cursory view, they look as if tossed about, and promiscuously heaped together, yet, on closer examination, this irregular appearance seems to arise chiefly from the presence of so many large valves of dead shells ; and, taking the general arrangement, they alternate very distinctly in layers.

The loose state of the soft clay may be explained in the following way :

This fossiliferous deposit unquestionably rests in a hollow or trough formed in the Boulder Clay. The open shelly clay of the deposit would take in more water from the surface than the stiff compact clay on which it reposes could withdraw, and an excess of water, accordingly, would be retained in the trough. When this was cut through at the deepest part by the excavation of the dock, and the superfluous moisture to some extent drained off, the deposit would naturally be brought much to its existing state.

Similar cases are by no means uncommon. In uncultivated moorlands, our footing is

often insecure, owing to impermeable hollows filled with silt or other porous material, and grown over with turf, which may remain in this state indefinitely, while the surface continues to supply the water, and the basin to retain it. Such conditions are well known to agriculturists, whose skill is exerted in discovering how they can best draw off the imprisoned water which impedes the fertility of their lands over particular areas.

The Boulder Clay, it may be added, is softer at the bottom of the trough immediately under the laminated clay than at a greater depth, doubtless owing to contact with the moister clay above.

There are facts, moreover, which cannot be reconciled with any mere drifting agencies.

1. The large boulders embedded in the shelly deposit. Many of these had marine organisms attached to them, and were not less than half a ton in weight.

Even with modern appliances one of these large blocks could not (the contractors informed us) be removed without blasting, and not one of them when uncovered had the slightest mark of a mallet or bore of a blast upon it.

2. Had the fossiliferous material been dug up from one place and carried to another by human agency, unmistakable tool-marks, cuts, and indentations of pike and shovel, would have been visible on the shells in their crowded condition; but not a single mark of this kind has been found.

3. Although the great mass of the shelly deposit lies in some apparent disorder, the under portions of it are distinctly laminated. Resting on the Boulder Clay there is an unevenly thin bed of reddish-brown clay, made up of very fine layers. Overlying this is a layer of whitish clay, about six inches thick, which is again covered by a layer of light grey clay, about one inch thick. These layers can be traced over the bed and up both sides of the trough, and it is impossible that sediment washed down through the loose materials above, as has been supposed, could have been accumulated in this manner. Again, had the layers been the immediate washings of the upper material, they would have been similar in colour and composition; but all three differed largely from the overlying clays, as well as amongst themselves in colour, constitution, and fossil contents.

The thin light-grey layer lying between the whitish six-inch layer and coarser shell-clay above contains one *Polyzoon* (*Idmonea fenestrata*, Busk) far more abundantly than we have found it elsewhere in the section. In this thin layer also occur the asbestos-like fibres of the shell of the common Mussel (*Mytilus edulis*), of which we have not found a vestige in the overlying clays. The six-inch stratum of whitish clay is, when dry, of an extremely friable character, and very like a stratum of clay met with in some of the Paisley brick-fields, and at Jordan Hill, in the same relative position; and the reddish-brown clay underlying this corresponds with the thinly laminated clays frequently found at the base of the fossiliferous clays of the Clyde district. Further, these underlying strata all contain organisms

of marine and arctic character, without the least admixture of those decided brackish-water forms so common in the present neighbouring lagoons of the Clyde.

4. At the south end of the hollow, lying between the shell-clay and the upper mould, a bed of brown clay is disclosed two feet in thickness which has never been disturbed since its original deposition.

As all these circumstances are incompatible with the supposition that this deposit has been interfered with by human agency, they are equally so with the theory that it has been drifted from any near or distant locality by the action of ice. The fossils bear no trace, moreover, of having been in any way rolled or crushed, as they would infallibly have been from such a cause.

Traces of a thin irregular bed of small shells have been seen near the surface along the south-east side of the dock; and about one hundred yards from this, in an easterly direction, another shelly deposit, belonging to the same series, has been exposed on the side of a sandstone quarry, where the shells and other organisms, though fewer in number and variety of species and different in their proportions, are similar in character to those we have described.

Another shell-bed, also of Arctic type, has been brought to light in making a channel way to the west end of the dock, rather below half-tide. That these beds at one time were all connected is highly probable; but there appears no evidence that any of them were ever covered by the Boulder Clay.

At first sight the deposit in the hollow, indeed, seems to dip under the Boulder Clay, but on further examination it is clearly seen to thin out to the surface.

The whole Frith of Clyde on both sides is patched with beds of laminated fossiliferous clay, which, doubtless, at one time covered the bottom from side to side, and reached the various heights on which we find their remains above the level of the sea. The whole deposit has evidently suffered much since it was first laid down, from currents, changes of level, and other causes.

The clays are generally found cut away between low tide and high-water mark, where the abrading power of the water is greatest. Examples may be seen at Langbank, Helensburgh, Roseneath, Fairlie, Cumbræ, &c. In these localities the truncated edges of the fossiliferous clays are exposed to view here and there in the more sheltered hollows along the tidal belt.

The trough at Cartsdyke has, doubtless, been separated from the deposit existing close by, near low-water-mark, by the agencies determining the distribution of the beds through the whole Frith.

The Cartsdyke deposit is remarkable, not only for its puzzling appearance, but for the great abundance and diversity of organisms found crowded within its narrow limits.

The dry fossiliferous clay consists of 76 per cent. fine mud; 19 per cent. fine and coarse sand; 5 per cent. gravel and shell *débris*.

The gravel has chiefly been derived from the sandstones of the neighbourhood, with fragments of quartz and mica-schist, and the greater portion is less or more water-worn and striated.

In our list of Mollusca sixty-one species and seven varieties have been identified. The two prevailing shells are *Pecten Islandicus* and *Mytilus modiolus*, but perhaps the shell of most geological interest in this deposit is *Pecten maximus*, as it has been considered doubtful whether it lived at the same time in the Clyde beds with *Pecten Islandicus* or at a subsequent period. Questions have been raised regarding *P. maximus*, which show the necessity of extreme care in cataloguing supposed "glacial" fossils of any description.

It is very doubtful, indeed, whether *P. maximus* belongs to the group of shells found in the true glacial clays.

1. It is not uncommon as a living species in the Frith of Clyde, and its valves abound in the upper silts and raised beaches, and specimens really belonging to the younger beds may have been accidentally mingled with the older fossiliferous deposits beneath. From such mixtures catalogues of species from the "Clyde beds" have often been augmented.

2. There is a *Pecten maximus* bed (presently to be described) immediately in contact in some localities with the older Arctic shell-clays on which it rests.

3. *Balanus* have never been found attached to *P. maximus*, yet in the glacial beds they are common on *P. Islandicus*; and as *B. porcatus* and *B. crenatus* (which are remarkably large and abundant in the Arctic clays) do not seem at all fastidious in their choice of attachment, whether to a stone or shell, we may reasonably infer that most of the shells of *P. maximus* found in the Clyde beds were not cohabitants with *P. Islandicus*.

4. With the exception of the one valve met with at Carlsdyke, *P. maximus* has only been found in beds between high and low water which have been greatly disturbed and re-arranged again and again by storm and tide.

This argument regarding *P. maximus* has been given to show the necessity of great caution in making deductions regarding the percentage and range of species generally in the whole series of glacial beds. Whether such deductions are made from the Ostracoda or the Mollusca, the same argument applies with equal force.

Height above the sea ten to twelve feet.

The following Ostracoda were found :

*Argillæcia cylindrica*, G. O. Sars.

*Pontocypris mytiloides* (Norman).

— *trigonella*, G. O. Sars.

*Cythere pellucida*, Baird.

- *porcellanea*, Brady.
- *viridis*, Müller.
- *lutea*, Müller.
- *clutha*, n. sp.
- *limicola* (Norman).
- *villosa* (G. O. Sars).
- *concinna*, Jones.
- *angulata* (G. O. Sars).
- *tuberculata* (G. O. Sars).

*Cytheridea papillosa*, Bosquet.

- *punctillata*, Brady.

*Eucythere Argus*, G. O. Sars.

*Loxoconcha tamarindus* (Jones).

- *fragilis*, G. O. Sars.

*Cytherura similis*, G. O. Sars.

- *pumila*, n. sp.
- *undata*, G. O. Sars.
- *striata*, G. O. Sars.
- *Sarsii*, Brady.
- *clathrata*, G. O. Sars.

*Cytheropteron latissimum* (Norman).

- *nodosum*, Brady.
- *angulatum*, Brady and Robertson.

*Bythocythere simplex* (Norman).

*Sclerochilus contortus* (Norman).

*Paradoxostoma variabile* (Baird).

- *Fischeri*, G. O. Sars.
- *tenerum*, n. sp.

*Polycopse orbicularis*, G. O. Sars.



## 12. CUMBRAE COLLEGE.

The following succession of beds was found during the sinking of a water-tank (1867) near the College in the Isle of Cumbrae :

|  |   |   |   |   |   |             |
|--|---|---|---|---|---|-------------|
| Earthy mould                             | . | . | . | . | . | 1 ft. 6 in. |
| Gravel                                   | . | . | . | . | . | 4 0         |
| Shell-bearing sand (not pierced through) | . | . | . | . | . | 1 6         |

The bed occurs at a distance of 200 yards from the shore, measuring from high-tide-mark.

On parts of the flat of slightly elevated ground, on which the excavation was made, beds of Nullipore, which is not now found in the neighbouring bay, are met with forming part of an old sea-beach and covered by a few inches of mould.

The shell-bed contains a large proportion of sand. Taking seven and a half pounds of the dried material, only ten ounces washed away through a sieve of 96 threads to the inch, leaving six pounds fourteen ounces residue. Of this residue one pound is composed of gravel and broken shells, retained in a sieve of  $\frac{1}{8}$ -in. mesh. The fragments of rock are sandstone, quartz, trap, and mica-schist, the larger pieces being mostly water-worn, while the smaller are generally angular or partially rounded. Some of the smooth stones appear to have been broken in two, and the fractured surface is entirely unworn.

Height above the sea thirty-two feet.

The following Ostracoda were found :

*Cythere castanea*, G. O. Sars.

— *porcellanea*, Brady.

— *Macallana*, Brady and Robertson.

— *viridis*, Müller.

— *lutea*, Müller.

— *albo-maculata*, Baird.

— *convexa*, Baird.

— *clutha*, n. sp.

*Cythere pulchella*, Brady.

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *limicola* (Norman).

*Cytheridea punctillata*, Brady.

— *papillosa*, Bosquet.

*Eucythere Argus*, G. O. Sars.

— *declivis* (Norman).

*Loxoconcha tamarindus* (Jones).

— *impressa* (Baird).

*Cytherura nigrescens* (Baird).

— *similis*, G. O. Sars.

— *undata*, G. O. Sars.

— *striata*, G. O. Sars.

— *Sarsii*, Brady.

— *clathrata*, G. O. Sars.

*Cytheropteron latissimum* (Norman).

— *nodosum*, Brady.

— *angulatum*, Brady and Robertson.

*Sclerochilus contortus* (Norman).

*Paradoxostoma variabile* (Baird).

### 13. KILCHATTAN, ISLE OF BUTE.

The deposit lies at the north-west side of Kilchattan Bay, beyond tide-mark, and dips seaward. Taking the beds in descending order, we find—

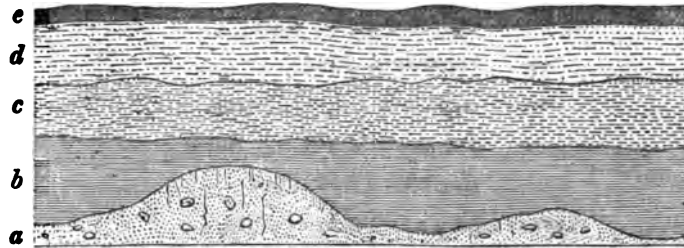
I.—Peaty mould: about 1 foot.

II.—Gravel: 3 to 5 feet.

III.—Muddy sand: 4 to 6 feet.

IV.—Grey laminated clay: 6 to 7 feet.

V.—Reddish Boulder Clay: depth unknown.



Section showing position of shell-bearing clay at Kilchattan  
Tile-works, Bute.

*a*, Boulder clay. *b*, Laminated clay. *c*, Sandy mud, with shells,  
&c. *d*, Gravelly mould. *e*, Peaty mould.

Passing over *e* and *d*, it is in the stratum of muddy sand (*c*) that the shells occur; and they are more abundant towards the bottom than near the top.

The prevailing shells of this deposit are *Tellina calcarea*, *Avinus flexuosus*, *Scrobicularia prismatica*, *Cyprina Islandica*, *Mya truncata*, and *Utriculus obtusus*. Most of these reach a size rather above the average of those met with in the Clyde beds generally. They are all abundant, from the fry up to the adult forms, showing, as regards this deposit, that the conditions for all stages of growth of these various species had been exceedingly favorable.

The majority of the *Myæ* were found to have both valves preserved, together with remains of their siphons in position within the shells. This sandy material seems to be favorable for the preservation of this portion of the animal tissue. Siphons have been met with in the soft clay of other localities, but rarely.

A number of the valves of *Mya truncata* have thick patches of the muddy sand in which they are imbedded indurated on their inner surface so firmly as not to be removed even by boiling water. Similar hard clays are occasionally found in shells taken from other Post-tertiary deposits. These patches generally do not extend over the whole interior of the shell, but are confined to a particular spot. Sometimes we have met with hard nodules of clay which, when broken, disclose a cluster of small shells embedded within, much like the well-known clay nodules enclosing shells or fish-remains in other formations.

These indurated patches of sand and clay within the shells, and those enclosing shells, as well as the clay-nodules found in many of our brick-clays, that have no apparent organic nucleus, have all, so far as we have examined, a strong calcareous base, while the clays in which they are embedded have none.

The grey-coloured laminated clay (*b*) is formed into layers by thin bands of red sand, which are thicker and more distinct as they approach the bottom, where the clay between them is again divided into exceedingly thin layers. From three pounds of this laminated

clay we obtained an oval plate of an *Echinus*, three valves of *Cytherura Sarsii*, twelve specimens of *Nonionina depressula*, and three of *Polystomella striato-punctata*.

A much larger portion from the same stratum had previously been examined without finding a vestige of animal remains, showing how unsafe it is to pronounce any deposit unfossiliferous from one trial, inasmuch as organisms may not be equally distributed through all parts of the same stratum.

The shell-bearing clay consists of 32 per cent. fine mud ; 68 per cent. fine sand.

The laminated clay when dry is of a lightish drab colour, and consists of  $96\frac{1}{2}$  per cent. fine mud,  $\frac{1}{2}$  per cent. fine sand, with occasionally small pebbles less than the size of a common pea.

The Boulder Clay, which is very unevenly distributed, and at some places rises up in knolls through the grey clay and nearly reaches the muddy sand layer above, when dry consists of 51 per cent. fine mud, 28 per cent. fine and coarse sand, 21 per cent. gravel.

Height above the sea fifteen to twenty feet.

The following Ostracoda were found :

*Argillæcia cylindrica*, G. O. Sars.

*Cythere castanea*, G. O. Sars.

— *porcellanea*, Brady.

— *Macallana*, Brady and Robertson.

— *viridis*, Müller.

— *lutea*, Müller.

— *Clutha*, n. sp.

— *limicola* (Norman).

— *pulchella*, Brady.

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Eucythere Argus*, G. O. Sars.

*Loxoconcha tamarindus* (Jones).

*Cytherura nigrescens* (Baird).

— *gibba* (Müller).

*Cytherura similis*, G. O. Sars.

— *undata*, G. O. Sars.

— *Sarsii*, Brady.

*Cytheropteron latissimum* (Norman).

#### 14. KYLES OF BUTE.

1. *Tigh-na-bruaich*.—Walking along the shore, and proceeding from high-tide-mark to low, the following series of beds is passed over :

(1.) Boulder Clay, hard, compact, unfossiliferous. It is red in colour through the ferruginous character of the mica-schist of which the included boulders largely consist, and which constitutes the base rock on which it rests.

(2.) Laminated clay, remarkable for the decisiveness and freedom of its laminations and of the same character as that described in other beds.

(3.) Shell-clay, rich in characteristic Arctic shells. This bed is composed of clay and sand mixed in various proportions at different points. At some points a pure sand, at others a pure clay, is found, and there are all possible intermediate varieties.

To the left of the pier, covered with one to two feet of sand, is an extensive bed of *Pecten Islandicus*, the shells having both valves united, and being in their natural position.

*Saxicava* (*Panopæa*) *Norvegica* with *Mya truncata*, var. *Uddevalensis*, also occur in a thick clay, adjoining the sand, of large size, standing in their natural boring position. *Astarte compressa* and *A. sulcata* can be picked out from the clay also with united valves, and large valves of *A. borealis* may also be found.

To some of the boulders imbedded in the clay large specimens of *Balanus porçatus* are attached.

The true order of these beds is the reverse of the order in which they are passed over in walking from high- to low-tide-mark. The action of the sea has swept away the upper parts of the beds ; and since the denudation has been most complete where the waves have broken upon the shore, the lowest bed (the Boulder Clay) is the most exposed at that point ; the middle bed (the laminated clay) is still less exposed ; and the upper bed (the shell-clay) is the least exposed of the whole series. This order is invariable through the whole length of the Kyles, although one or other of the beds is occasionally absent. Fossils might appear at first sight to be in the Boulder Clay when they really occur at points where the fossiliferous bed is in immediate contact with it, the laminated clay being absent.

On the Bute shore, immediately opposite Tigh-na-bruaich, the same beds are visible

wherever any jutting point has saved them from denudation. In some places a bed of *Mya truncata* runs under the turf, and is above high-tide-mark, while the Boulder Clay is seen beneath it, the shell-bed having been more perfectly protected than on the opposite side of the water; *Saxicava Norvegica* of very large size is *in situ*, and any lump of clay yields numerous examples of *Tellina calcarea*.

2. *Balnakeaile Bay*.—In this bay, which is almost directly opposite to Colintrave Pier, the glacial beds have been well preserved; they are cut through by a small stream which discharges itself into the sea in the middle of the bay, and exposes the clay with characteristic Arctic species *in situ*. On the left of the stream the shell-bed extends under a bank of sand and gravel, rising to a height of twenty feet; and it also crops out in the wood, a quarter of a mile inland, on the same side of the stream. The nature of the matrix in which the shells are found varies from a loose sand to a tenacious clay.

Following the Rothesay Road, in a slight bend of the Kyles opposite the first farmhouse, the shell-bed has been found in great perfection. It is now almost washed away, but a few years ago the remains of an Arctic fauna were multitudinous. A bed of *Pecten Islandicus* existed and many of the specimens had *Balanus porcatus* attached to their upper valves; *B. porcatus* adhered also to large boulders on the shore. In those beds we have also found *Balanus cariosus* (Darwin) and *Modiolaria nigra*; and *Saxicava Norvegica* was in great perfection. The beds occur in the same order as at Tigh-na-bruaich, and the shell-bed extends from high-tide-mark towards the sea, at about half-tide being at its thickest. Before it can be well seen a foot or more of sand and gravel must be removed. Collections made from the mere surface *débris* are worthless, since they will be found to contain Arctic, raised-beach, and recent species intermixed in inextricable confusion.

3. *Ettrick Bay*.—This bay on the Bute shore, near the westerly entrance to the Kyles, is so completely covered with sand as to obscure the separate beds. It is noteworthy, however, as the locality in which *Astarte borealis* may be found in great abundance, generally in single valves, although we have obtained a perfect specimen.

Height above the sea from half-tide to about fifteen feet.

The following Ostracoda were found :

- Cythere pellucida*, Baird.
- *viridis*, Müller.
- *lutea*, Müller.

*Cythere limicola* (Norman).

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Eucythere Argus* (G. O. Sars).

*Loxoconcha tamarindus* (Jones).

*Cytherura nigrescens* (Baird).

— *similis*, G. O. Sars.

— *undata*, G. O. Sars.

— *striata*, G. O. Sars.

— *Sarsi*, Brady.

— *flavescens*, Brady.

*Cytheropteron latissimum* (Norman).

— *nodosum*, Brady.

— *angulatum*, Brady and Robertson.

*Sclerochilus contortus* (Norman).

*Paradoxostoma variabile* (Baird).

— *ensiforme*, Brady.

#### 15. EAST TARBERT, LOCH FINE.

On the north side of the Tarbert Loch, at the north-east corner, a small stream, called the Black Burn, cuts into a bed of clay containing Arctic shells, which can be traced from twelve to fifteen feet above high-water mark.

The shell-bearing clay is of a light grey colour and lies at an incline of one foot in ten. It is overlaid by five or six feet of brown stony mould washed down from the hillside. In washing through a sieve of 96 meshes to the inch, 100 parts of the dry material lost thirty, while ten parts of the residue were retained in a sieve of  $\frac{1}{8}$ -inch mesh and consisted of coarse gravel; the other sixty parts were composed of fine gravel and sand. The presence of water-worn specimens of species, natives of different habitats, raises a suspicion that they may have been brought after death from greater or less distances; although some specimens which have their colour and epidermis preserved are evidently on the ground on which they lived.

*Trochus helycinus* is remarkably prevalent, and in no one of the glacial beds we have examined has it been found so abundantly as in this locality.

*Saxicava rugosa* is next in abundance, and the var. *arctica* appears, although not of marked size, few specimens reaching an inch. Portions of the epidermis are preserved. A few fragments of *Mya truncata* are met with covered with fresh epidermis, and, therefore, evidently washed from a near part of the bed where they must be *in situ*.

*Littorina litorea*, *L. obtusata*, and *L. limata* (which are all very scarce, especially *L. limata*) are imperfect and water-worn.

There is one curious circumstance characteristic of these local groupings, in which the facts connected with the fossils coincide with those connected with recent deposits, and which it is important for the geologist to consider when collecting palæontological evidence regarding the ages of the beds. Almost all the deposits have their peculiarly prevalent species. A rare species in one bed may be abundant in another, belonging to precisely the same age.

In the East Tarbert bed *Pseudocythere caudata*, of Sars, is moderately common. It is recorded as rare between tide marks in the Channel Islands; rare in England, Scotland, Ireland, and Norway in deep water; and it is also rare in the glacial clays.

*Cythere emarginata* (Sars), a still rarer species, is met with in the same bed; male and female specimens being moderately common.

This species has been found living only in one or two localities in the British seas, and there very sparingly.

Height above the sea twelve to fifteen feet.

The following Ostracoda were found :

*Cythere pellucida*, Baird.

— *castanea*, G. O. Sars.

— *viridis*, Müller.

— *lutea*, Müller.

— *villosa* (G. O. Sars).

— *angulata* (G. O. Sars).

— *emarginata* (G. O. Sars).

— *concinna*, Jones.

— *tuberculata* (G. O. Sars).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Cytherura nigrescens* (Baird).

— *undata*, G. O. Sars.



- Cytherura similis*, G. O. Sars.  
 — *Sarsii*, Brady.  
 — *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
*Pseudocythere caudata*, G. O. Sars.  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma variabile* (Baird).

## 16. WEST TARBERT.

For a considerable distance along the Loch on the south side, a little beyond where the new road begins near the head of the Loch, a fossiliferous clay crops out, in some places abutting against the native rock to which *Balan*i and *Serpula* may be seen adhering in great abundance.

A little further down the Loch, where the rocks stand out more steeply into the sea, the shell-bearing clay disappears, but it is seen again in the course of about a mile, resting against the rock on the west side of the bay. Considerable denudation has, therefore, taken place.

Many parts of the true bed are overlain by eight or ten inches of a shell *débris* thickly mixed with clay. This covering is undoubtedly a wash thrown up in heavy storms and is coated with grass. Many of the shells in the lower clay, especially *Pecten Islandicus* and *Buccinum undatum*, have attained a portly size, evidencing their growth under secure and favorable conditions.

One hundred parts of the dry clay lost 66 per cent. in washing through a sieve of 96 meshes to the inch; 16 parts of the residue were retained in a sieve of  $\frac{1}{8}$ th-inch mesh, consisting of small gravel and broken shells; the other 18 parts were composed of fine sand.

Height above sea, just above and beneath high-water-mark.

The following Ostracoda were found :

- Cythere pellucida*, Baird.  
 — *viridis*, Müller.  
 — *lutea*, Müller.  
 — *pulchella*, Brady.  
 — *villosa* (G. O. Sars).  
 — *concinna*, Jones.  
 — *angulata* (G. O. Sars).

- Cythere tuberculata* (G. O. Sars).  
 — *Dunelmensis* (Norman).  
*Cytheridea papillosa*, Bosquet.  
 — *punctillata*, Brady.  
*Loxoconcha tamarindus* (Jones).  
*Cytherura nigrescens* (Baird).  
 — *undata*, G. O. Sars.  
 — *striata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
 — *angulatum*, Brady and Robertson.  
*Bythocythere simplex* (Norman).  
*Sclerochilus contortus* (Norman).

## 17. LOCH GILP.

The burn in the excavated banks of which the shell-clay is found begins in the marshy ground west of Baden farm-head. When this burn was deepened shell-bearing deposits were brought to view at several points along its course, variously overlain by gravel, peat, and surface-soil, to the depth of five to ten feet.

Directly beneath the shell-clay is the Boulder Clay, with the following characteristics :

1. It is very hard and compact, and tinged with the bluish hue of the surrounding trap-rocks.
2. It is exceedingly irregular in thickness, and curves violently within a few yards.
3. The boulders are chiefly schist and greenstone, and very far-travelled ; they are finely striated, smoothed, and polished.
4. It does not contain the slightest vestige of a shell.

This Boulder Clay rests upon greenstone rock, striated in horizontal or partly dipping grooves.

It is not succeeded by the usual laminated clay of the Clyde beds. A remarkable shell-bed rests immediately upon the Boulder Clay.

The line of junction between the shell-bed and Boulder Clay is sharp and well defined. There is no merging of the shell-bed into Boulder Clay, and no gradual transition. The separation is sharp, and in every way decisive.

Scarcely at any two places where the shells appear is the composition of the deposit alike. Some portions lose by washing about 10 per cent. and others about 60 per cent.

In some parts there is a thick blue clay ; in others, a mixture of clay and sand, varying from a sandy clay to a clayey sand.

On the north side of the burn blue clay is overlain by about a foot of gravelly clay, with boulders of various sizes thickly interspersed, not unlike a shore shingle. In this gravelly clay *Mya truncata* is exceedingly plentiful in its natural boring position, with both valves united. It also occurs in the underlying blue clay, more than a foot and a half lower down.

The burrow of this Mollusc, however, never exceeds half that depth, and consequently the *Mya* of the upper bed could not have been contemporaneous with the *Mya* of the lower; and we have the record of successive generations.

The fauna of the shell-bed is most abundant; but the grouping of the shells, like the composition of the deposit, varies at different points. At one spot *Mya truncata* abounds, the shells being thickly packed in a sandy matrix, and in many cases having their syphons preserved. At another, this shell is absent, and *Saxicava rugosa* stands in its natural position, and *Astarte borealis* is found with united valves. The smaller shells, and even the Entomostraca, equally vary in grouping at different points. We have, in fact, all those local varieties of *habitat* characterising a sea-bottom. There is no sign of any confused sweeping of one part into another.

The occurrence of the shell-bed in patches may be due either to the irregular character of the surface over which the shell-bearing deposit is spread, or to abrasion from above.

Of the former, there are good illustrations in many of the brickfields near Paisley in which knolls of Boulder Clay rise up through the laminated clay and at some places reach the surface. Of the latter, there is a good instance on the shore at high-water mark, a little east of Helensburgh, where a patch of shell-bearing clay lies in a rent or gully of Boulder Clay and has been worn down to a level with the beach.

At one point in the Loch Gilp sections the shell-bed dips under the stream, which is literally paved with *Mya truncata* in a boring position.

A few boulders are scattered through the shell-bed; but grooved and polished specimens are not as abundant among them as they are in the clay beneath, although they occasionally occur. The change is almost as great from striated to unstriated imbedded stones, as from the absence of a fauna to its abundant development.

The boulders in the shell-bed are often covered with *Serpulae*, and evidently, therefore, must have been stationary during a certain period. They are small in size compared with those in the clay beneath.

Above the shell-bed in one locality is a patch of fine sand (two to three feet) destitute of organic remains, and this is succeeded by a bed of about the same depth of ferruginous gravel. The whole of these deposits, however, vary in thickness at different points. In some places the sand thins out, in others the gravel disappears and a bed of mere surface-soil covers the shells.

The complete section is :

1. Surface-soil ;
2. Ferruginous gravel :
3. Fine sand (marine in one place, at which we found *Cardium edule*) ;
4. Fossiliferous clay, passing into sand ;
5. Boulder Clay.

Height above the sea fifteen to twenty feet.

The following Ostracoda were found :

*Pontocypris trigonella*, G. O. Sars.

*Cythere pellucida*, Baird.

— *viridis*, Müller.

— *lutea*, Müller.

— *Finmarchica* (G. O. Sars).

— *villosa* (G. O. Sars).

— *mirabilis*, Brady.

— *concinna*, Jones.

— *quadridentata*, Baird.

— *conveza*, Baird.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Eucythere Argus* (G. O. Sars).

*Loxoconcha tamarindus* (Jones).

*Xestoleberis depressa*, G. O. Sars.

— *aurantia* (Baird).

*Cytherura nigrescens* (Baird).

— *gibba* (Müller).

— *similis*, G. O. Sars.

— *undata*, G. O. Sars.

— *striata*, G. O. Sars.

— *Sarsii*, Brady.

— *clathrata*, G. O. Sars.

*Cytheropteron latissimum* (Norman).

*Bythocythere simplex* (Norman).

*Sclerochilus contortus* (Norman).

*Paradoxostoma variabile* (Baird).— *abbreviatum*, G. O. Sars.— *Fischeri*, G. O. Sars.— *flexuosum*, Brady.

## 18. CRINAN.

This bed was opened by a cutting made to lead off the water from the high level on a small plateau at the north side of No. 11 Lock on the Crinan Canal.

A few feet only of the clay are exposed, and the shell-bearing portion is a thin stratum, in which broken shells, *Balani* plates, and spines of *Echini* are seen sparsely scattered. The shells are of Arctic species, including *Astarte borealis*, *Tellina calcarea*, *Pleurotoma pyramidalis*, and *Velutina levigata*, but so fragmentary as to be determinable with difficulty. The *Balani*—*B. crenatus*, *B. porcatus*, and *Verruca Stroemii*—are more abundant and less broken, but of small size.

The clay is reddish-brown and loses 66 per cent. in washing.

Height above the sea thirty feet.

The following Ostracoda were found :

*Cythere lutea*, Müller.— *villosa* (G. O. Sars).— *concinna*, Jones.— *angulata* (G. O. Sars).— *tuberculata* (G. O. Sars).*Cytheridea punctillata*, Brady.*Krithe Bartonensis* (Jones).*Loxoconcha impressa* (Baird).— *tamarindus* (Jones).*Cytherura undata*, G. O. Sars.— *clathrata*, G. O. Sars.*Cytheropteron latissimum* (Norman).— *nodosum*, Brady.— *angulatum*, Brady and Robertson.*Sclerochilus contortus* (Norman).

## 19. DUNTROON.

This deposit occurs a little to the south of Duntroon Castle and comes to the surface at about high-water-mark. By clearing away a slight covering of gravelly sand a stiff brown clay is reached, containing many of the typical Arctic species of this series of beds in abundance.

*Pleurotoma pyramidalis* is particularly plentiful.

The clay when dry imbibes the water very slowly, pieces from three to four inches in diameter taking nearly twenty-four hours to dissolve; nevertheless, it passes easily through the sieve and washes rapidly, losing 83 per cent. in the operation.

Height above the sea, just above high-water-mark.

The following Ostracoda were found :

*Argillæcia cylindrica*, G. O. Sars.

*Pontocypris trigonella*, G. O. Sars.

*Cythere castanea*, G. O. Sars.

— *viridis*, Müller.

— *lutea*, Müller.

— *limicola* (Norman).

— *pulchella*, Brady.

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Eucythere Argus* (G. O. Sars).

*Krithe Bartonensis* (Jones).

*Loxoconcha impressa* (Baird).

— *tamarindus* (Jones).

*Cytherura nigrescens* (Baird).

— *similis*, G. O. Sars.

— *pumila*, n. sp.

*Cytherura undata*, G. O. Sars.

— *Sarsii*, Brady.

— *cellulosa* (Norman).

— *clathrata*, G. O. Sars.

*Cytheropteron latissimum* (Norman).

— *nodosum*, Brady.

— *angulatum*, Brady and Robertson.

*Bythocythere constricta*, G. O. Sars.

*Sclerochilus contortus* (Norman).

*Paradoxostoma variabile* (Baird).

*Polycope orbicularis*, G. O. Sars.

## 20. DYER'S BURN, FORT WILLIAM.

A section has been exposed by this burn, about half a mile from Fort William, a little above the bridge.

A brief account of this bed, with a complete list of its fauna, has been given by Mr. J. Gwyn Jeffreys in the 'Transactions of the British Association for the Advancement of Science' for 1862.

We observed the following particulars:

Upon the schistose rock of the locality (over which the stream pours) rests a bed of hard and stony clay.

*a.* The lower part of this clay is crowded with fossils, which are intermixed with stones and pebbles of schist. To some of the stones *Balani* are attached.

*b.* The upper part of the clay contains some angular blocks with many stones confusedly massed together, which have the appearance of having been thrown down upon the shell-bed, possibly while it was in the process of elevation.

The clay is about five to six feet deep, and in the lower foot the fossils are most abundant.

On the neighbouring hillside two beds of coarse gravel and shingle may be seen; the one, about forty feet above the sea, representing an old coast-line, the other, about twenty-five feet above the sea, representing a more recent coast-line.

Among the Mollusca included in the shell-clay are *Columbella Holbollii*, *Littorina limata*, *Margarita Grænländica*, &c. Mr. Jeffreys considers the whole group, however, Scandinavian rather than Arctic.

Height above the sea nine feet.

The following Ostracoda were found :

*Cythere lutea*, Müller.  
 — *concinna*, Jones.  
*Cytheridea punctillata*, Brady.  
*Cytherura gibba* (Müller).  
*Cytheropteron latissimum* (Norman).  
 — *angulatum*, Brady and Robertson.  
*Sclerochilus contortus* (Norman).

# 21. LUCKNOW PIT, ARDEER IRON-WORKS, AYRSHIRE.

Although we could obtain no material from this pit to examine for Ostracoda, it is of importance to record the section as illustrating the existence of a younger fossiliferous bed (represented by the *Pecten maximus* bed in the Kyles of Bute and the Irvine water bed presently to be described) resting upon an older Arctic bed.

The section obtained during the sinking of the pit was the following :

|                               |   |   |   |   |   |   |              |
|-------------------------------|---|---|---|---|---|---|--------------|
| Sand, about                   | . | . | . | . | . | . | 12 ft. 0 in. |
| Moss .                        | . | . | . | . | . | . | 1 6          |
| Sand .                        | . | . | . | . | . | . | 26 6         |
| Shell-mud, or blue loamy sand | . | . | . | . | . | . | 6 0          |
| Blue clay                     | . | . | . | . | . | . | 6 0          |
| Sandstone rock                | . | . | . | . | . | . |              |

The shells brought to the surface belonged to two entirely different groups. The one group was eminently Arctic, including *Leda arctica*, *Astarte borealis*, *Tellina calcarea*, *Natica affinis* (*clausa*).

The other group embraced a numerous collection of species precisely similar to those found in the post-glacial bed in Irvine water. In this group *Ostrea edulis* is abundant and associated with *Cardium edule*, *C. Norvegicum*, *C. echinatum*, *Tapes pullastra*, *T. decussata*, *Lutraria elliptica*, *Pecten opercularis*, *Trochus magnus*.



## 22. CLESHMAHEW'S TILE-WORKS, ONE MILE SOUTH OF STRANRAER.

The following section has been exposed :

1. Upper clay, mixed with sand, with polished and striated stones and worn flint pebbles . . . . . 7 to 8 ft.
2. Brown clay . . . . . Very variable.
3. Blue clay rising into hummocks and occasionally intersected by lenticular beds of sand and gravel, with polished and striated stones and worn flint pebbles . . . . . 7 to 8 ft.
4. Gravel, sufficiently porous to drain the water from the workings, not pierced through . . . . .

The shells are found in the brown clay (2) and the blue clay (3).

The species of Mollusca, which are not water-worn, although ill-preserved, include such an extremely Arctic type as *Leda arctica*, which is covered with its epidermis and is associated with *L. pygmæa* and *L. pernula*.

The shell-clay consists of 92 per cent. fine mud, 6 per cent. sand, 2 per cent. small gravel.

Height above the sea fifty feet.

The following Ostracoda were found :

*Cythere lutea*, Müller.

— *villosa* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea punctillata*, Brady.

*Loxoconcha tamarindus* (Jones).

23. TERALLY BRICK-WORKS, FOURTEEN MILES FROM STRANRAER, ON THE SOUTH-EAST  
OF THE MULL OF GALLOWAY.

This deposit is of the same general character as at Cleshmahew's except that the undermost bed retains the water instead of being porous. It is also remarkable for the prevalence of a highly Arctic fauna.

*Leda arctica* (Torell) is associated with *L. pygmæa*.

The shell-clay consists of 97 per cent. fine mud, 2 per cent. of sand, and 1 per cent. of gravel.

Height above the sea forty-five feet.

The following Ostracoda have been found :

*Cypris gibba*, Ramdohr.

*Cythere limicola* (Norman).

*Limnocythere antiqua*, n. sp.

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

*Cytherura undata*, G. O. Sars.

24. PORT LOGAN CLIFFS.

Port Logan cliffs are about one mile from Terally on the opposite side of the Mull. The shell-clay rests immediately on the rock, and rises to the height of twenty feet. It is very stiff, and is overlain by a few feet of gravel.

The dry clay consists of 50 per cent. of fine mud, 46 of sand, and 4 of rounded and well polished gravel.

The shells are fragmentary and water-worn; they are scattered over the whole face of the deposit, and not confined to any particular layer in the section, as we see them in those sections where they have lived and died.

Only three species of Mollusca could be determined, viz. *Astarte sulcata*, *Leda pernula*,

and *L. pygmæa*, with one of Ostracoda, viz. *Cytheridea punctillata*, Brady, which was a perfect specimen with united valves.

#### 25. DIPPLE TILE-WORKS, THREE MILES EAST OF GIRVAN.

The clay in this deposit is remarkable for the character of its fauna, as showing a direct passage from marine through estuarine to freshwater conditions.

Freshwater, brackish, and marine forms are not mixed up promiscuously together from bottom to top, but the fauna is nearly pure marine at the bottom, brackish in the middle, and almost entirely freshwater at the surface. Three samples of the clay were examined.

The uppermost part, between six and nine feet below the surface, is distinctly laminated, and of a dark mottled appearance. Together with some vegetable remains it contains a great abundance of the chitinous parts of Daphniadæ and Lyncæidæ, various forms of Cypridæ, and other genera and species which have a greater or less aptitude for existence in brackish water, such as *Limnocythere inopinata*, *Loxoconcha tamarindus*, and *Cythere tenera*.

Some shell fragments are associated with the Ostracoda,—possibly of *Mytilus edulis*, which can exist at high-water-mark, and would be lifted up with the sea-bottom when it was placed in a position to become a freshwater pool.

Under this freshwater clay we find four feet of clay of a uniform grey colour, in which the brackish water forms are very largely developed. A few freshwater species occur, such as *Sphærium corneum* and *Cypris gibba*; but brackish water forms, such as *Cythere castanea* (which is very abundant), greatly prevail. The appearance of *Utriculus obtusus* and *Homalogyra atomus* also shows that the clay is beginning to assume a more decidedly marine character.

In the succeeding three feet of clay the freshwater and brackish organisms have almost disappeared, and the Mollusca are far more numerous, both in species and individuals, than in any of the overlying strata. Taking them in the prevailing order, they are :

|                          |   |   |   |                    |
|--------------------------|---|---|---|--------------------|
| <i>Homalogyra atomus</i> | . | . | . | Very common.       |
| <i>Rissoa striata</i>    | . | . | . | Moderately common. |
| <i>Utriculus obtusus</i> | . | . | . | Moderately common. |
| <i>Leda pygmæa</i>       | . | . | . | Moderately rare.   |
| <i>Axinus flexuosus</i>  | . | . | . | Three valves.      |
| <i>Skenea planorbis</i>  | . | . | . | One valve.         |

|                            |   |   |   |                 |
|----------------------------|---|---|---|-----------------|
| <i>Mya truncata</i>        | . | . | . | Fry, one valve. |
| <i>Mytilus edulis</i>      | . | . | . | Fragments.      |
| <i>Balanus crenatus</i>    | . | . | . | One plate.      |
| <i>Fry of Gasteropoda.</i> |   |   |   |                 |
| <i>Claw of Crustacean.</i> |   |   |   |                 |

The following Ostracoda were found :

- Cypris compressa*, Baird.
- *ovum* (Jurine).
- *gibba*, Ramdohr.
- Pontocypris mytiloides* (Norman).
- *trigonella*, G. O. Sars.
- Cythere castanea*, G. O. Sars.
- *tenera*, Brady.
- *lutea*, Müller.
- *pulchella*, Brady.
- *villosa* (G. O. Sars).
- *concinna*, Jones.
- *angulata* (G. O. Sars).
- *tuberculata* (G. O. Sars).
- Limnocythere inopinata* (Baird).
- *antiqua*, n. sp.
- Cytheridea papillosa*, Bosquet.
- *punctillata*, Brady.
- *lacustris* (G. O. Sars).
- Loxococoncha tamarindus* (Jones).
- Cytherura nigrescens* (Baird).

## 26. ERROL, PERTHSHIRE.

On the north side of the River Tay, eight miles east from Perth, a clay is exposed remarkable for the intensely Arctic character of its fossils.

1. Its surface is covered by the estuarine mud of the Tay.
2. The deposit of clay itself occupies a small oval trough about one mile in length

and a quarter of a mile in breadth, and the clay is at its extreme point twenty-five feet deep.

3. The lower part of the clay is distinctly laminated, as in the Paisley and other beds, and is far more sandy than the upper clay, becoming, indeed, the workmen informed us, a sand bed at its deepest point.

4. The trough in which the fossiliferous clay is packed is a hollow in the Boulder Clay, which crops out on neighbouring elevations.

The shells are met with at all points from the bottom to near the surface, but are most abundant (as in the Paisley beds) in the lower part of the clay.

Nothing can be more striking than the general physical conformity between the section at Errol, when fully exposed, and a good typical section in the neighbourhood of Paisley.

The Errol clay contains certain species, either absent or extremely scarce in the west, mixed with others entirely identical; and the high northern character of these peculiar species may either indicate a slight precedence in time on the part of the eastern beds and the consequent prevalence of a sterner climate; or it may (as is far more probable) be explained by local peculiarities of depth and exposure. The remarkable conformity between the two series of clays in their sequences and characteristics, unmistakeably proves, however, that they must have been formed by the exercise of the same physical forces acting under the same conditions and with similar degrees of intensity and power.

The whole of the Mollusca found, specially in the eastern fossil beds, range within the Arctic circle and off the east coast of North America, and do not live off the coast of Great Britain; and although the percentage of species collected in the several beds must always be shifting with fresh discoveries, there seems no doubt that in such glacial clays as those of Errol on the east of Scotland, as compared with those upon the west, there is a preponderance of Arctic and North-east-American forms.

The following species of an extremely Arctic character have not yet been found in the west:—*Crenella faba*, *Leda limatula*, *Mesalina erosa*, *Mesalia reticulata*, *Thracia myopsis*.

*Leda arctica* is a characteristic fossil at Errol; every lump of clay in some parts of the pit is crowded with them. On the west it is extremely scarce. One specimen, evidently fossil, was dredged by Mr. Jeffreys; another was obtained from a sand bed (glacial) at Stevenson; and a few specimens have been found in Cleshmahew's Tile-works and Terally Brick-works, near Stranraer.

*Pecten Grænländicus* is also far from uncommon at Errol; as yet only one young specimen has been found in the west; and that in the bed beneath the Boulder Clay at Tangy Glen.

*Modiolaria discors*, var. *lævigata*, is also abundant at Errol, while only rare specimens of the fry have been found in the west.

The Ostracoda yield a kindred result.

In the fossiliferous clays of Errol such species as *Cythere mirabilis*, *Cytheridea Sorbyana*, and *Cytheropteron Montrosiense*, occur with an abundance sufficient to be characteristic, while they are exceedingly rare in the western beds.

The existence of an Arctic current on the east, such as that which now sweeps over the Dogger Bank, might sufficiently account for the preponderance in question without having recourse to any larger hypothesis.

Height above the sea forty-five feet.

The following Ostracoda have been found :

*Cythere viridis*, Müller.

— *lutea*, Müller.

— *convexa*, Baird.

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *globulifera*, Brady.

— *emarginata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *mirabilis*, Brady.

— *Dunelmensis* (Norman).

*Cytheridea papillosa*, Bosquet.

— *punctillata*, Brady.

— *Sorbyana*, Jones.

*Krithe glacialis*, n. sp.

*Cytherura concentrica*, n. sp.

— *gibba* (Müller).

*Cytheropteron latissimum* (Norman).

— *nodosum*, Brady.

— *arcuatum*, n. sp.

— *inflatum*, n. sp.

— *Montrosiense*, n. sp.

*Scleruchilus contortus* (Norman).

## 27. ELIE, FIFESHIRE.

On the coast of Fife, eleven miles from St. Andrews, and on the north side of the bay in which the town of Elie is situated, there is an exposure of sandy clay, containing a fauna kindred to that at Errol, and to which the same general remarks apply.

The beds occur in the following order :

1. Drift sand.
2. Gravel, variable in thickness.
3. Sandy clay, with Arctic fauna ; about four feet being exposed above high-water mark, and the bed passing under the sea.

The fossils are met with throughout the clay.

Height above the sea, from high-water mark to four feet.

The following Ostracoda were found :

- Cythere globulifera*, Brady.
- *concinna*, Jones.
- *emarginata* (G. O. Sars).
- *mirabilis*, Brady.
- *Dunelmensis* (Norman).
- Cytheridea papillosa*, Bosquet.
- *punctillata*, Brady.
- *Sorbyana*, Jones.
- Eucythere Argus* (G. O. Sars).
- Loxoconcha tamarindus* (Jones).
- Cytherura concentrica*, n. sp.
- *nigrescens* (Baird).
- Cytheropteron arcuatum*, n. sp.
- *Montrosiense*, n. sp.
- *latissimum* (Norman).
- Krithe Bartonensis* (Jones).
- Sclerochilus contortus* (Norman).

## 28. DRYLEYS, NEAR MONTROSE.

In the brickworks of Dryleys, near Montrose, a thick mass of clay is exposed which reaches the height of 50 to 100 feet.

In the lower part of the mass especially fossils occur, and the presence of *Leda arctica*, *Pecten Grænländicus*, a large form of *Saxicava rugosa*, var. *arctica*, sufficiently marks the character of the deposit.

Height above the sea forty feet.

The following Ostracoda were found :

- Cythere globulifera*, Brady.
- *concinna*, Jones.
- *mirabilis*, Brady.
- *Dunelmensis* (Norman).
- Cytheridea punctillata*, Brady.
- *Sorbyana*, Jones.
- Cytherura concentrica*, n. sp.
- Cytheropteron latissimum* (Norman).
- *arcuatum*, n. sp.
- *inflatum*, n. sp.
- *Montrosiense*, n. sp.
- Sclerochilus contortus* (Norman).

## 29. BARRIE, FORFARSHIRE.

This clay bed is of the same general character as that of Dryleys. It lies along the estuary of the Tay, in a gully in the most recent of the raised sea-margins, which runs all along the east coast, nearly a mile inland.

The shells indicate a decidedly arctic character ; and amongst them are *Mya truncata*, *Nucula tenuis*, *Leda pernula*, and *Leda minuta*. *Hoploaster gracilis* is not uncommon.



The following Ostracoda were found :

- Cythere globulifera*, Brady.
- *villosa* (G. O. Sars).
- *emarginata* (G. O. Sars).
- *mirabilis*, Brady.
- *Dunelmensis* (Norman).
- Cytheridea punctillata*, Brady.
- Cytherura similis*, G. O. Sars.
- *concentrica*, n. sp.
- *Sarsii*, Brady.
- Cytheropteron latissimum* (Norman).
- *Montrosiense*, n. sp.

### 30. GAMRIE, BANFFSHIRE.

About seven miles east of Banff beds of fine sand and clay attain a height of upwards of 300 feet.

At an elevation of about 150 feet in a thin seam of sand, shells occur of an Arctic type, but the catalogues at present compiled do not show a group as intensely Arctic as that at Errol and Elie.

The beds at Errol and Elie, however, are at a much lower elevation, and possibly belonged to a deeper sea-bed during the period of the greatest submergence of the land.

Height above the sea 150 feet.

The following Ostracoda were found :

- Cythere pellucida*, Baird.
- *limicola* (Norman).
- *lutea*, Müller.
- *villosa* (G. O. Sars).
- *tuberculata* (G. O. Sars).
- *Finmarchica* (G. O. Sars).

*Cytheridea papillosa*, Bosquet.  
*Loxoconcha impressa* (Baird).  
*Cytherura undata*, G. O. Sars.  
— *similis*, G. O. Sars.  
— *Sarsii*, Brady.  
— *cellulosa* (Norman).  
— *clathrata*, G. O. Sars.  
*Cytheropteron latissimum* (Norman).  
*Sclerochilus contortus* (Norman).

## 31. ANNOCHIE, ABERDEENSHIRE.

At Annochie, about five miles north of Peterhead, a bed of fine fossiliferous clay occurs, passing immediately from the shore under the beach, thus occupying the same position as many outcrops of clay along the Clyde. As in the corresponding Clyde beds, such species as *Axinus flexuosus*, *Leda pygmæa*, and *Nucula tenuis* are very abundant.

Height a few feet above sea-level, the bed passing under the beach.

The following Ostracoda were found :

*Cythere globulifera*, Brady.  
— *Dunelmensis* (Norman).  
*Cytheridea inornata*, n. sp.  
*Cytherura complanata*, n. sp.  
*Cytheropteron latissimum* (Norman).  
— *Montrosiense*, n. sp.

## B.—ARCTIC SHELL-BEDS.

Although we have grouped together in one class the sands and clays characterized by an Arctic fauna, it does not necessarily follow that they belong to one period only of the great Glacial Epoch.

In many of the periods (possibly marked by fluctuations in the intensity of the climate) comprised within the epoch during which an Arctic climate prevailed and disappeared, marine clays must have been deposited and become the habitat of species now relegated to the Arctic circle.

Some of the beds must belong to the earlier, and some to the more recent portions of the epoch.

In considering the effects of fluctuations of climate upon marine animals, we must also take into account other modifying causes, such as depth of water, character of the sea-bottom, supply of food, and the abundance or otherwise of the enemies of particular species.

Without attempting to decide upon the special ages of the various Arctic deposits examined for the purposes of this paper, we must have made evident the fact that many differences exist between them.

I. The varying position of the Arctic shell-clays, with respect to the Boulder Clay, has been described.

1. Some Arctic shell-clays are covered by masses of highly glaciated Boulder Clay.
2. Other Arctic shell-clays are intercalated between masses of Boulder Clay.
3. Other Arctic shell-clays rest upon the Boulder Clay, and not only are not covered by it but are followed by a regular succession of beds, showing a very gradual change from old marine to recent estuarine conditions, and entirely free from any indications of violent breaks.
  - a. Beds of this class are deposited in hollows of the Boulder Clay, and have thus been formed subsequently to an extensive denudation of that material.
  - b. They contain large boulders, not derived from the Boulder Clay on which they rest, but which have been dropped upon existing sea-bottoms full of marine life.
  - c. They enable us to trace the coming and going of the Arctic fauna by the examination of the clays at the lower and upper parts of the same section, as was indicated in an account of a Paisley pit.
  - d. They are often immediately succeeded by a *Cardium edule* bed of a modern period, without any intervening Boulder Clay at all.
  - e. Sometimes the passage from marine through estuarine to freshwater beds can be followed by examining samples of one bed of clay taken from different points in the section.

An example of this was given from the tileworks near Girvan, Ayrshire.

II. Some Boulder Clays have themselves been distinguished as fossiliferous and as being Arctic shell-bearing clays, although found under special circumstances.

III. The study of the special fauna of each bed reveals also distinctions between them.

1. The shell-beds represent differences of depth, some being littoral and others deep sea.

2. They contain sometimes a mixture of deep-sea and littoral species, evidencing the action of tides and changing currents.

3. While in many beds the fossils occur *in situ*, in others they are very much broken and fragmentary.

4. The proportion of Arctic species varies in different beds.

IV. Some of the Arctic shell-beds mark coast-lines at varying heights—coast-lines which could not have coexisted. The case of Jordan Hill, Glasgow, has been instanced, where a littoral shell-bed exists sixty-three feet above the sea; while a similar littoral shell-bed is met with on the low ground north of Paisley at about fifty feet lower level.

V. The Arctic shell-beds exist at various heights above the sea. On the west of Scotland the beds we have described range from 526 feet at Airdrie (the highest point at which Arctic shells have yet been discovered in Scotland, although there is no reason to conclude that they will not ultimately be found at higher levels) to half-tide-mark, where, in some cases, they dip beneath the sea and are entirely hidden by modern sands and gravels. At present there are blanks to be filled up between 526 feet (Airdrie) and a group of beds between forty feet and sixty feet. Tangy Glen, Campbelton, is 130 feet; and, doubtless, other beds at a corresponding elevation await discovery.

Between forty feet and sixty feet we have such beds as those at Oakshaw Hill, Paisley, Paisley and Glasgow Canal, Jordan Hill, Stranraer, &c.

Between twenty feet and forty feet such beds as those at Paisley (lower levels), Loch Lomond, Loch Gilp, Crinan, &c.

Between ten feet and twenty feet, such beds as those at Greenock, East Tarbert, Dumbarton, &c.

Between high-tide-mark and ten feet, such beds as those at Kyles of Bute and almost the whole shore of the Frith of Clyde, Fort William, &c.

On the east of Scotland, Arctic shell-beds have been found at the following heights:

|   |            |
|---|------------|
| Auchleuchries, Aberdeenshire (this bed we have not seen, but give     |            |
| it on the authority of Mr. Jamieson, <i>loc. cit.</i> , <i>ante</i> ) | 300 ft.    |
| Gamrie (the beds of sand and gravel reaching to 300 feet)             | 150        |
| King Edward   | 150 to 200 |
| Errol   | 45         |
| Belhelve, Aberdeenshire   | 40         |
| Montrose  | 40         |
| Annochie (passing under sea from a few feet over sea-level).          |            |
| Elie (passing under sea from a few feet over sea-level).              |            |

VI. The position of the *Mytilus edulis* bed is also noteworthy.

The range of *Mytilus edulis* is given by Mr. J. Gwyn Jeffreys as "From high-water mark to the depth of a few fathoms."<sup>1</sup> The bed occurs in the lower part of some of the Arctic deposits, and in the upper part of others.

The *Mytilus edulis* bed was found resting on the surface of a glacial clay, itself covered by forty-two feet of Boulder Clay, on Oakshaw Hill, Paisley, sixty-four feet above the mean sea-level. Dr. Fraser states that he has found a similar bed "under the late steeple at the Cross of Paisley, at a height of forty feet above the sea-level; another at the head of St. Mirren Street at thirty-two feet; another in James's Street at twenty-three feet; and another in Causey-side at a height of only twelve feet; while out in the plain, and nearer the Clyde, he had found a fringe of shells, seaweed, &c., which marked the tidal limit, subsequent, of course, to the time when the lowest of these beds was formed."<sup>2</sup>

C.—Among the Post-tertiary fossiliferous beds of Scotland there is not only this vast series of Arctic sands and clays (in themselves possibly marking various points in the passage of a great epoch), BUT THERE IS ALSO A SERIES OF BEDS, OF LATER DATE AND NOT IN ANY WAY ARCTIC IN CHARACTER, WHICH INDICATE THE STEPS THROUGH WHICH THE PRESENT CLIMATE AND PHYSICAL GEOGRAPHY OF SCOTLAND HAVE BEEN REACHED SINCE THE FINAL RETREAT OF THE ICE.

During the complex conditions arising from the subsidence and emergence of the land, it does not seem reasonable to suppose that the climate of Scotland was ameliorated by unbroken stages. A season of less heat may have been followed by a season of greater heat than even now exists, in its turn to be modified by the changed distribution alike of the currents of the waters and the respective areas of the land and sea.

*1. Some deposits, belonging to the class now under consideration, may, indeed, be quoted as furnishing indications of a climate certainly far from Arctic, and possibly of a more genial character than now prevails in Scotland.*

#### 1. BLAIR DRUMMOND, VALLEY OF THE FORTH.

The following section is given on the authority of Mr. Jamieson:<sup>3</sup>

1. Sandstone rock.
2. Glacial beds.

<sup>1</sup> 'British Conchology,' vol. ii, p. 105.

<sup>2</sup> 'Trans. Geol. Soc. Glasgow,' vol. iv, p. 180.

<sup>3</sup> 'Quart. Journal Geol. Soc.,' vol. xxi, p. 185, 1865.

3. Peat with remains of trees.
4. Carse-clay with bones of Whale.
5. Peat, with roots of oak trees at the bottom and remains of an old wooden road.

The peat (3) is described as a "land-surface of the period preceding the deposition of the old estuarine mud," and commented upon as follows—"This bed of peat, lying beneath the raised estuarine beds, is the first appearance of that substance we meet with in Scotland; indeed the period during which peat was formed so extensively from the gradual accumulation of mosses, sedges, and various other plants, is, perhaps, even a stage later; for at the bottom of many of our peat-mosses we find remains of trees and, in some cases, beds of shell-marl. These trees are all of existing species now indigenous to Scotland. The birch, hazel, and oak are amongst the most common, and hazel nuts are frequently found. Now these trees testify, I think, *to a condition more favorable to the growth of wood than what we have at present*. They evidently preceded the commencement of the peat in a multitude of instances, for their roots are spread on the hard earthy soil beneath it, and it is since the death of those trees that many of our peat-mosses date."<sup>1</sup>

Evidence is also brought to show that the remains of trees are now found in Scotland "at heights beyond where wood can now be got to grow."<sup>2</sup>

## 2. COLINTRAIVE, KYLES OF BUTE.

Following the Loch Ridden Road on the Colintrave side of the Kyles of Bute, in a small bay, about a quarter of a mile from the pier, a shell-bed is exposed at low-tide which has been confounded with the true glacial clay, but which certainly belongs to a very different age. In this deposit *Pecten maximus* and *Ostrea edulis* occur, of enormous size, associated with *Aporrhais pes-pellicani*, *Lutraria elliptica*, *Psammobia Ferroensis*, *Lucinopsis undata*, *Tellina squalida*, all British species, but constituting a group of shells which could not now be obtained in the same abundance and perfection in the immediately neighbouring waters of the Kyles.

It is true that the partial or total disappearance of shells on particular banks depends, in a large measure, on local circumstances, which may be of comparatively recent occurrence. It is not unusual when dredging to find banks, at various depths, covered with old dead shells, without a living one of the same species among them. In the bay, at the head of West Tarbert Loch, a little below high-water, on digging through a foot of sand, a bed of sandy mud was reached, with large specimens of *Scrobicularia piperata*,

<sup>1</sup> Ibid, p. 186.

<sup>2</sup> Ibid., p. 187.

although none are now found living in that locality, the destruction having been evidently occasioned by a bank of sand having been thrown over the haunts of that Mollusc during a violent storm. After every great storm, indeed, there is probably some change in the habitats of the Mollusca.

The *Pecten maximus* bed at Colintrave, however, contains species which would require, when living, a greater depth of water than they could have enjoyed in their present situation.

It can be traced along the shore until it can be seen resting upon an old glacial clay containing in abundance *Tellina calcarea*; and this, again, may be seen resting on the laminated clay, and the laminated clay on the Boulder Clay, in regular descending order.

It is evident that at the junction of the edge of the *Pecten maximus* bed with the Arctic clay, it will be possible for the contents of the two beds to be confused together.

We have observed this same *Pecten maximus* bed cropping out in various districts. It may be seen at dead low-water near Tigh-na-bruaich and at Kilchattan Bay, Bute.

At Fairlie (Ayrshire) it is largely developed, and, as at Colintrave, overlies the Arctic shell-clay. The ground at Fairlie has been so often dug and re-dug by collectors that the natural difficulties in the way of discriminating between the two beds have been increased, and very little, if any, reliance can be placed upon the accuracy of catalogues of so-called 'glacial fossils' based upon specimens from that locality. Not only specimens from the *P. maximus* bed, but recent specimens have been thrown together in the *débris* of the very numerous excavations which have been made, and have thence made their way into collections and catalogues as belonging to the "Clyde Beds."

The Ostracoda found are a mixture from the various beds now described, species from one deposit having been washed into another, so that it is not necessary to give a separate catalogue of them.

### 3. IRVINE WATER, AYRSHIRE.

On the Ayrshire coast, in the neighbourhood of Irvine, a fine sand similar to that now edging the sea has been deposited and drifted inland to a considerable distance, rising in a succession of slightly elevated knolls. Near the shore these knolls are most distinctly marked, having been recently formed, and their loose material not having been driven over the dividing gaps made by the wind. Inland their divisions have been to a great extent obliterated by perpetual driftings, but excavations show the sand rising and falling

at different heights, exactly as in the line of hillocks now fronting the sea. Following the Irvine Water, at about two miles from the sea, a section of clay and sand beds was cut out by a curve of the stream. Of all sections of this character it must be noted that the looseness of the material causes them quickly to appear and disappear, so that the observations made at one season cannot often be repeated.

The section we examined was the following :

1. The base of the section was the Boulder Clay of the true normal type. The boulders, chiefly of trap and limestone, were not very far-travelled, and were beautifully striated. As usual this Boulder Clay had sharp undulations and dipped violently within short distances, rising nearly to the surface in one direction and passing down rapidly beneath the stream, a variation of one to twenty feet in its height taking place within a quarter of a mile.

The Boulder Clay was capped occasionally along the line of its outcropping by a few feet of ferruginous gravel. This gravel, as well as the Boulder Clay, has been greatly denuded, and occurs in patches only. It may be recognised in good sections of the glacial series of beds, as at Lochgilphead, where it covers the Arctic deposit, but it is not at all persistently found.

3. Here occurs a vast gap in the normal arrangement of the strata. The Boulder Clay was *not* followed by the series of glacial fossiliferous sands and gravels of the Clyde district, but was simply covered here and there by a layer of peat a few inches less or more in thickness.

4. Following the peat appeared the first great shell-bed in the section. At the point described the Boulder Clay was hollowed out and disappeared under the stream.

The old clay had evidently been disintegrated, and its boulders rolled upon a beach. The small boulders scattered about were of the same composition as those of the older bed, but their striations were gone, and they had evidently been subjected to the rolling action of the waves.

Among the shells embedded in this old sea-bottom not a single purely Arctic form could be detected, although it was twenty feet beneath the surface, and rested immediately on the Boulder Clay.

The valves of the specimens were generally loose and separate, yet several perfect examples were extracted, and from the very bed of the stream a fine example of *Macra stultorum* was obtained *in situ*, clearly proving that it was not a mere drift-bed, but that many of the Mollusca lived and died upon the spot. The action of the Irvine Water, often rising to great heights, would be sufficient to break up the shells and scatter them on the banks.

5. Upon this rough sea-bottom, with its stones washed out from the disintegrated Boulder Clay, rests the fine sand of the district. In this sand, fourteen feet from the surface, and about four feet above the average level of the stream, immediately before our



visit, a considerable portion of the occipital bone, with the condyles, foramen magnum, and pterygoid process of a large Cetacean had been found.

6. The same fine sand continued to the surface, and was broken by a second shell-bed, nearly two feet in depth, and extending along the section in a regular and persistent line. This shell-bed must have been deposited *after* the Cetacean stranded in the hollow of the Boulder Clay, since it is unbroken in regularity, and has not been disturbed subsequently to its deposition.

The shells have not been roughly heaped up, as a drift, by wind and tide, since many perfect specimens, fresh as when they were first interred in the sand, were obtained from the bed. *Tellina tenuis* was extracted with both valves entire, together with numerous perfect examples of *Macra subtruncata*. This second shell-deposit indicates a less depth of water than the one preceding. Its contents consisted of such species as *M. subtruncata*, *Tellina tenuis*, whose special habitat is the sand in shallow water, while from the lower bed were obtained *Cyprina Islandica* and *Lutraria elliptica*, which range to greater average depths.

The rough stones of the lower bed gave place to the finer sands, and the waters becoming more shallow through the gradual elevation of the land, the nature of the characteristic fauna slightly changed during the process.

The *lowest* shell-bed is possibly of the same age as the *Pecten maximus* bed of Colintrave and other localities; but, however this may be, the fact of the occurrence of distinct beds of shells of undoubtedly post-glacial character proves the necessity for their separate description and examination, and establishes the fact that a series of gradual changes took place in comparatively recent times.

The following Ostracoda were found :

*Cythere pellucida*, Baird.

— *lutea*, Müller.

— *convexa*, Baird.

— *albomaculata*, Baird.

— *villosa* (G. O. Sars).

— *emaciata*, Brady.

*Cytheridea elongata*, Brady.

*Loxoconcha impressa* (Baird).

*Cytherura nigrescens* (Baird).

— *undata*, G. O. Sars.

*Paradoxostoma variabile* (Baird).

II.—*A strongly marked series of Post-glacial deposits belongs to the most recent period of the depression of the land.*

These beds when fossiliferous contain precisely the same fauna as that now occupying British waters. They are, however, sometimes distinguished (*a*) by a general grouping of species in slightly different proportions from those now prevalent in the waters of the special locality, and (*b*) by the rarity or absence in the immediately neighbouring waters of a species abundant in the fossil bed.

The deposits, which may be classed together as belonging to the close of the last period of the depression of the land, range from a little above the sea-level to a height of about forty feet, and may be described as *raised beaches* and *estuarine beds*.

A.—Estuarine muds compose the Carse Lands of Scotland, and are largely developed in the Firth of Tay and the Firth of Forth. The mud is in no way stony, but exceedingly fine and smooth, and has not been disturbed since its first deposition.

A series of bores (investigated by Mr. Croll and Mr. J. Binnie<sup>1</sup>) “reveal the existence of a deep trough or channel, running from the Clyde Valley, near Bowling, up to and through the haugh of Belmore, the valley of the Kelvin, and round by the south-east end of the Campsie Hills into the valley of the Forth by Grangemouth;” and one of these will clearly show the general position of the estuarine mud.<sup>2</sup>

Bore near Skinflats, Grangemouth, twelve feet above sea-level.<sup>3</sup>

|  |         |
|--|---------|
| 1. Surface sand . . . . .  | 6 feet. |
| 2. Soft mud with shells [estuarine, <i>Ostrea edulis</i> very large—<br>many recent species] . . . . . | 11      |
| 3. Blue mud and sand (hard) . . . . .  | 3       |
| 4. Channel (rough gravel) . . . . .  | 3       |
| 5. Fine sand [shell fragments] . . . . .   | 8       |
| 6. Running sand (red and fine) . . . . .   | 17      |
| 7. Red clay . . . . .  | 30      |
| 8. Soft till [Boulder Clay] . . . . .  | 36      |
| 9. Sand (pure) . . . . .   | 2       |
| 10. Soft till [Boulder Clay and sand] . . . . .  | 17      |
| 11. Gravel . . . . .   | 8       |
| 12. Hard blue till [Boulder Clay] . . . . .  | 14      |

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<sup>1</sup> ‘Trans. Geol. Soc. of Glasgow,’ vol. iii, page 141.

<sup>2</sup> With respect to this channel between the Forth and Clyde it must be noted that when the land stood higher the trap-dyke which crosses the Clyde near Dalmuir would have assisted in forming the deep portions of the trough into a lake such as Loch Lomond now is, with its bar at Balloch.

<sup>3</sup> Ibid., p. 144.

Through the Carse of Forth these beds extend to a great depth. Near Falkirk the bores show the centre of the trough to be 300 feet deep, the deposits decreasing rapidly on either side. The thickness of the different beds of the series naturally varies at different points all over the area covered by them.

Entire skeletons of the Whale (about seventy feet long) were found at Airthrey and Dunmore, twenty feet above tide-mark, imbedded in the clay,<sup>1</sup> and portions of Cetacean remains near Stirling, Micklewood, and Blair Drummond. The fauna is entirely modern, and many species occur in extraordinary quantities in large and well-developed beds which are scattered through the whole of the districts covered by the carse clay precisely as at the sea-bottom of the present day. Near Micklewood, five miles west of Stirling, *Cardium edule* is abundant, *Mytilus edulis* and *Ostrea edulis* common.

In a section exposed on the banks of the Allan, *Ostrea edulis* is seen in layers.

In the Montrose estuarine basin, *Scrobicularia piperata* is the most characteristic shell.

Some shells of an Arctic character, such as *Tellina calcarea* and *Trophon scalariforme*, have been reported from the Carse of Falkirk;<sup>2</sup> but these evidently belong to a bed of the older clay which has survived the denudation, and occupies a position beneath the estuarine mud, probably indicated by No. 5 of the Grangemouth section quoted. During the sinking of one of the Grangemouth pits at a depth of eighty feet (sixty or seventy feet below sea-level) some bones of a Seal were found.<sup>3</sup> From mud adhering to these bones, we obtained *Polymorphina compressa* and *Nonionina asterizans*, with one species of Ostracoda, viz. *Cytheropteron Montrosiense*, a species associated with Arctic Mollusca in the old Arctic clays. Some clay from the same pit at a depth of forty feet yielded fragments of *Tellina balthica*, a species more frequent in estuarine than in glacial beds.

### 1. DRIP BRIDGE, STIRLING.

A few yards above Stirling Bridge, the river exposes a fossiliferous bed of marine clay covered by later estuarine mud. By comparing one or two similar and neighbouring exposures, the following series was obtained :

1. Peat . . . . . 7 ft. to 8 ft.
  - (a) Upper part black, useable for fuel.
  - (b) Lower part soft and spongy not so useable.

<sup>1</sup> 'Edin. Phil. Journ.,' vol. i, p. 393; vol. xi, p. 220.

<sup>2</sup> 'Trans. Geol. Soc. of Glasgow,' vol. 3, p. 367.

<sup>3</sup> See a paper by Prof. Turner, "On the Bones of a Seal in the Red Clay at Grangemouth," in the 'Proceedings Roy. Soc. Edinb.,' 1869-1870.

|                             |   |   |   |   |                 |
|-----------------------------|---|---|---|---|-----------------|
| 2. Carse mud                | . | . | . | . | 9 ft. to 10 ft. |
| 3. <i>Ostrea edulis</i> bed | . | . | . | . | 2·6 „ 3 „       |

The sample of clay containing the shells washed quite away, leaving neither sand nor gravel, but simply shell *débris* mixed with a little vegetable matter.

*Ostrea edulis* is very abundant. None of the specimens, however, are as large as those we have noticed in the *Pecten maximus* bed at Colintrave, few exceeding four inches in their longest diameter, although they are generally very thick and solid.

Height above the sea thirty-four feet.

The following Ostracoda were found :

*Argillæcia cylindrica*, G. O. Sars.

*Cythere pellucida*, Baird.

— *viridis*, Müller.

— *villosa* (G. O. Sars).

— *concinna*, Jones.

— *angulata* (G. O. Sars).

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Cytheridea torosa* (Jones).

*Eucythere Argus* (G. O. Sars).

*Loxoconcha guttata* (Norman).

— *tamarindus* (Jones).

*Cytherura nigrescens* (Baird).

— *similis*, G. O. Sars.

— *clathrata*, G. O. Sars.

*Cytheropteron nodosum*, Brady.

*Sclerochilus contortus* (Norman).

## 2. BRICK-WORK SOUTH-WEST OF STIRLING.

At McAlpin's brickwork, south-west of Stirling, there is a stiff clay of a dark colour, composed of fine mud with a small percentage of sand and gravel. Estuarine shells are

exceedingly numerous, *Scrobicularia piperata* being the characteristic mollusc, and they are not associated with any Arctic forms.

The following Ostracoda were found :

*Cythere pellucida*, Baird.

— *lutea*, Müller.

— *villosa* (G. O. Sars).

*Cytheridea punctillata*, Brady.

*Loxococoncha guttata* (Norman).

*Cytherura clathrata*, G. O. Sars.

*Cytheropteron nodosum*, Brady.

### 3. BRIDGE OF ALLAN.

About half a mile from the Bridge of Allan, on the north side of Allan Water, the river cuts through a bank in which the *Ostrea edulis* bed is exposed a few feet below the surface.

The following Ostracoda were found :

*Potamocypris fulva*, Brady.

*Cythere pellucida*, Baird.

— *cribosa*, nov. sp.

— *viridis*, Müller.

— *villosa* (G. O. Sars).

— *angulata* (G. O. Sars).

— *cuneiformis*, Brady.

— *tuberculata* (G. O. Sars).

— *Dunelmensis* (Norman).

*Eucythere Argus* (G. O. Sars).

*Loxococoncha guttata* (Norman).

— *tamarindus* (Jones).

*Cytherura undata*, G. O. Sars.

— *nigrescens* (Baird).

*Cytheropteron latissimum* (Norman).

*Sclerochilus contortus* (Norman).

The estuarine muds at the mouth of the South Esk are typical, and the following series of deposits has been described by Dr. Howden :<sup>1</sup>

" 1. A layer of unstratified Boulder Clay, of a red colour, lying on rocks polished and grooved in a general direction of west to east, and containing the dressings of these rocks and travelled boulders derived from rocks to the west of their present position.

" 2. Laminated dull red clay, forming a terrace forty feet above the level of the sea and containing marine fossils of an Arctic type and small boulders (transported from great distances) of rocks foreign to the district.

" 3. A layer of stratified sand and gravel covering the laminated and boulder clay to 100 feet above the sea-level, identical in its mineral contents with the unstratified moraine-gravels of Glen Clova.

" 4. Peat found in old water-courses, resting on the marine clay or on the gravel.

" 5. A great bar of boulders stretching across the estuary mouth, derived apparently from the Boulder Clay.

" 6. *A deposit of estuary or Carse clay and sand, extending to about fifteen feet above the sea-level, and containing in its lower portions estuary shells.*

" 7. An accumulation of blown or drifted sand, forming the links on part of which Montrose is built."

Since these old estuarine deposits and raised beaches occur at almost any point between a few feet above high-water mark and thirty feet, the amount of elevation of the land during the period they represent (as we pointed out was the case also during the glacial period) must have been very unequal.

Mr. Jamieson states that the elevation of the old estuarine deposits becomes less as we proceed from the Firth of Forth to Aberdeenshire,<sup>2</sup> commencing at from twenty-five to forty feet in the Carse clay of the Forth and continuing at that point to the estuary of the Tay, but at the estuary of the Ythan being eight feet and at Aberdeen only just above high-water mark.

#### 4. PAISLEY, CARDIUM EDULE BED.

The position of this bed has been previously described (p. 25). It was about nine inches in thickness and covered with four feet of surface soil. Immediately beneath it was the Arctic shell-clay, in the upper part containing few fossils, in the lower part an abundant fauna, with *Cyprina Islandica* as the characteristic species.

<sup>1</sup> 'Trans. Ed. Geol. Soc.,' 1867-68.

<sup>2</sup> 'Journal Geol. Soc.,' 1865, vol. xxi, p. 189.

The fauna of the *Cardium edule* bed was similar to the fauna of any locality on the west coast in which that species abounds. In a very small quantity of material the following Ostracoda were found :

*Cythere pellucida*, Baird.  
*Cytheridea papillosa*, Bosquet.  
*Loxoconcha impressa* (Baird).  
*Xestoleberis aurantia* (Baird).  
*Cytherura gibba* (Müller).

##### 5. ISLE OF CUMBRAE.

The village of Millport, which stretches along the shore, is built on the old twenty-five-feet sea-beach. From the pier to the west end of Kames Bay, under a thin crust of soil, is a bed of *Melobesia*, more or less thick, which, for the most part, rests on the sandstone rock of the district. It is curious to notice that, although at this stretch of the beach the *Melobesia* is lying in beds of considerable thickness, none of it is found in the sea in the bay opposite to it ; but at the south-west end it is most abundant, both in the raised beach and in the sea.

The fauna is entirely recent. The shelly material is much water-worn, and loses little in washing. Mollusca are more abundant than either Foraminifera or Ostracoda.

The following Ostracoda were found :

*Pontocypris mytiloides* (Norman).  
 — *trigonella*, G. O. Sars.  
 — *acupunctata*, Brady.  
*Cythere pellucida*, Baird.  
 — *viridis*, Müller.  
 — *lutea*, Müller.  
 — *albomaculata*, Baird.  
 — *convexa*, Baird.  
 — *pulchella*, Brady.  
 — *villosa* (G. O. Sars).  
 — *angulata* (G. O. Sars).  
*Cytheridea papillosa*, Bosquet.

*Loxoconcha impressa* (Baird).  
*Xestoleberis aurantia* (Baird).  
*Cytherura nigrescens* (Baird).  
 — *angulata*, Brady.  
 — *acuticostata*, G. O. Sars.  
*Paradoxostoma Fischeri*. G. O. Sars.

## 6. WEST TARBERT SILT.

A bed of estuarine silt is found at West Tarbert, younger than the glacial clay previously described, and entirely free from any remains of Arctic shells.

The following Ostracoda were found :

*Pontocypris mytiloides* (Norman).  
*Cythere pellucida*, Baird.  
 — *castanea*, G. O. Sars.  
 — *porcellanea*, Brady.  
 — *crispata*, Brady.  
 — *viridis*, Müller.  
 — *lutea*, Müller.  
 — *albo-macculata*, Baird.  
 — *convexa*, Baird.  
 — *cuneiformis*, Brady.  
 — *villosa* (G. O. Sars).  
 — *tuberculata* (G. O. Sars).  
*Loxoconcha impressa* (Baird).  
 — *tamarindus* (Jones).  
*Xestoleberis depressa*, G. O. Sars.  
*Cytherura nigrescens* (Baird).  
 — *undata*, G. O. Sars.  
 — *striata*. G. O. Sars.  
 — *cuneata*, Brady.  
 — *gibba* (Müller).  
 — *cellulosa* (Norman).  
*Paradoxostoma variabile* (Baird).  
 — *Fischeri*, G. O. Sars.



## 7. OBAN.

A bed composed of earthy matter, shell *débris*, and small gravel, was reached in digging the foundation of a house on the east of Oban, and also in a railway-cutting in the same vicinity. The material is more muddy and has less of a washed appearance than is usual in raised beaches.

It occurs on a small plateau at the mouth of a rivulet which might have supplied the sediment. Only one example of fluviatile Ostracoda, however, was found,—a solitary specimen of *Cytheridea lacustris*. The deposit has altogether the appearance of a recent sea-bottom, which has been uplifted to its present position, rather than of a beach. The fauna is that of the surrounding waters.

Height above the sea ten to fifteen feet.

The following Ostracoda were found :

- Paracypris polita*, G. O. Sars.
- Pontocypris mytiloides* (Norman).
- *trigonella*, G. O. Sars.
- Bairdia inflata* (Norman).
- Cythere lutea*, Müller.
- *viridis*, Müller.
- *pellucida*, Baird.
- *castanea*, G. O. Sars.
- *crispata*, Brady.
- *albo-maculata*, Baird.
- *convexa*, Baird.
- *pulchella*, Brady.
- *villosa* (G. O. Sars).
- *angulata* (G. O. Sars).
- *semipunctata*, Brady.
- *Jeffreysii*, Brady.
- *cuneiformis*, Brady.
- *laticarina*, Brady.
- *emaciata*, Brady.
- *antiquata* (Baird).
- Cytheridea torosa* (Jones).

- Cytheridea lacustris* (G. O. Sars).  
*Loxoconcha impressa* (Baird).  
 — *tamarindus* (Jones).  
*Xestoleberis depressa*, G. O. Sars.  
*Cytherura nigrescens* (Baird).  
 — *similis*, G. O. Sars.  
 — *striata*, G. O. Sars.  
 — *angulata*, Brady.  
 — *undata*, G. O. Sars.  
 — *gibba* (Müller).  
 — *acuticostata*, G. O. Sars.  
 — *cellulosa* (Norman).  
*Cytheropteron latissimum* (Norman).  
*Pseudocythere caudata*, G. O. Sars.  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma variabile* (Baird).  
 — *abbreviatum*, G. O. Sars.  
 — *arcuatum*, Brady.
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#### § IV. GENERAL SEQUENCE OF THE POST-TERTIARY BEDS OF SCOTLAND.

While the place of several individual deposits—the precise nature of the causes by which they were produced—and the subdivisions of the periods to which they may be referred, involve geological arguments beyond the scope of the present paper, it may add to the clearness of those details, distinctive of the beds from which Ostracoda have been derived, and which have been already dwelt upon, to subjoin a reference to the General Sequence of the Post-Tertiary Beds of Scotland.

In tabulating this general sequence itself, however, we shall confine ourselves almost entirely to points illustrated by our previous descriptions of the several beds with the fauna of which this Monograph is chiefly concerned.

Without attempting to give anything approaching to a final and complete sequence we simply submit an arrangement, *in the direction of which our investigations have led us*, for the purpose of furnishing a tentative grouping of a large number of deposits which it is impossible to study when they are miscellaneously intermingled.

## A. PREGLACIAL PERIOD.

"Crag" of Aberdeenshire.

Beds beneath Boulder Clay at Kilmaurs, with remains of  
*Elephas primigenius*.

## B. GLACIAL PERIOD.

I. *Early Glacial Period.*

Elevation of the land above its present level.

Land ice.

Formation of unfossiliferous Boulder Clay, now found :

(a) On the flanks, in the hollows, and on the summits of  
Scotch mountains, as well as beneath more recent  
deposits in the plains.

(b) Beneath the Arctic shell-clays of the Clyde.

II. *Middle Glacial Period.*

Depression of the land.

Denudation of Boulder Clay.

Formation of Arctic shell-beds in hollows of Boulder Clay at  
various depths, according to extent of local depression.

Floating ice over the sea increased in area by the depression.

Boulder Clay thrown over shell-beds : (a) by glacier reaching  
the sea ; or (b) floating ice.

Earliest *Mytilus edulis* beds, formed when depression began,  
followed by clays with shells of deeper range as depression  
increased.

Period of extreme depression.

III. *Final Glacial Period.*

Re-elevation of land.

Gradual shallowing of the waters.

More littoral character of glacial shell-beds.

Later *Mytilus edulis* beds.

Floating ice ; dropping glaciated Boulders into shell-beds.  
Boulder Clay occasionally thrown, as before, over shell-beds.  
Gradual filling up with sand and silt of great sea-channels,  
formed during period of greatest depression, as, *e.g.* between  
Firth of Forth and Firth of Clyde. During this process  
Boulder Clays *possibly* deposited by floating ice over sand and  
silt—their alternation as now found being caused by seasonal  
changes.  
Drifting ice breaking up shell-beds and mixing their contents  
with Boulder Clay, especially along the newly forming coasts.

### C. POST-GLACIAL PERIOD.

#### I. *Early Post-glacial Period.*

Upper Raised Beaches, formed as the land rose from the Glacial  
Sea, during the gradual amelioration of the climate.  
Upper portions of Clyde clays, showing by absence of species  
common in lower portions, the disappearance of an Arctic  
fauna and the incoming of estuarine conditions.  
Land almost at its present level.

#### II. *Middle Post-glacial Period.*

Possibly milder climate.  
Peat with trees, showing conditions very favorable to growth.  
Slight resubmergence of the land.  
*Pecten maximus* bed at Irvine water, Colintrave, &c.  
Lower estuarine mud ; possibly *Scrobicularia* bed of silt of east  
coast.

#### III. *Final Post-glacial Period.*

Re-elevation of land to its present position.  
Last Raised Beaches.  
Upper estuarine mud.

The final *Post-glacial Period* we regard as terminating with the last elevation of the  
land, at however recent a date that may have taken place.

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NOTE.—With regard to the Ostracoda which we have catalogued from the various Post-tertiary beds of Scotland the only previous notices of their occurrence known to the authors of this Monograph are the following :

1. Dr. Howden, in his paper "On the Superficial Deposits of the South Esk,"<sup>1</sup> catalogues among the principal fossils found at the Dryley's Brick-work, Montrose—CRUSTACEA, *Cythere*, sp. (?)

2. Memoirs of the Geological Survey of Scotland: Explanation of—

SHEET I.—Terally Brick-works.

*Entomostraca*: A few single valves much worn.

SHEET II.—Monreith Tile-works.

*Cythere emarginata*?

— *pulchella*?

3. Mr. Peach's paper "On the Fossils from the Boulder-clay of Caithness," in 'Report of British Assoc.,' 1862, Trans. Sect., p. 83, includes—ENTOMOSTRACA, some valves of *Cythere*?

## V. THE POST-TERTIARY OSTRACODA.

In this Monograph we describe 133 species, of which 93 are from the Post-tertiary beds of Scotland. The species from the upper beds are the same as those inhabiting the British seas at the present day, and their distribution corresponds; but when the Ostracoda catalogued from the true glacial deposits of Scotland are studied in connection with the Mollusca, they yield the same general results both with respect to their relationship to the fauna now inhabiting British waters and also to the glacial fossil fauna of Norway and Canada.

A few of these general relationships may be indicated. The names of the fossil species to which reference is made will be given when we proceed to notice in detail the facts connected with their distribution.

<sup>1</sup> 'Trans. Geol. Soc. Edin.,' 1867-8, p. 6.

1. *Relation of the Scotch glacial fauna to the existing fauna of the Scotch waters.*

From the results of Mr. J. Gwyn Jeffrey's dredging expedition in the Hebrides<sup>1</sup> it may be concluded that—

(1) The invertebrate fauna of the district is chiefly northern, and for certain species peculiar to the Hebrides no locality has been recorded between that and the Mediterranean. The fauna of the Hebrides must have obtained this characteristic subsequently to the Glacial Epoch.

(2) The Hebrides constitute the southern limits of many northern species, such as *Lima elliptica* (not yet found fossil), *Leda pygmæa* (an abundant glacial fossil), *Trochus Groenlandicus* (also abundant as a glacial fossil).

Of the Mollusca catalogued from the Scotch glacial beds none are extinct species, but some Arctic forms are absent from the neighbouring sea, while some species ranging within the Arctic circle may be characterised as very common in glacial clays and very rare as living specimens.

Of the species of Ostracoda catalogued from the Post-tertiary beds—

18 are extinct, so far as at present known ;

10 are distinctly boreal or Arctic, although living in British waters ;  
and none of the remainder are of southern type.

2. *Relation of the Scotch glacial fauna to the glacial fauna of the north of Europe.*

Prof. Sars gives sixty-one species of Mollusca collected from twenty beds of the old Glacial Epoch in Norway. Of these sixty-one species we have obtained forty-eight from the glacial clays of Scotland. Moreover, the characteristic species of some of the Norwegian clay beds are precisely identical with those of the Scotch beds.

At Moss, *e. g.* on the Christiania Ffiord the prevailing shell is *Leda Arctica*, which is also very characteristic of the Errol clay.

The climate of south-west Norway was undoubtedly more extreme than at present during the Glacial Epoch, and, so far as the evidence of the fauna reaches, the same severe climate extended over Scotland.

Of the forty-five fossil species of Ostracoda noted in the "Glacial and Post-glacial" beds of Norway all, except eight, are fossil in the Scotch beds, and all, except one, are living in British and Norwegian seas.

<sup>1</sup> 'Annals and Magazine of Natural History,' 1866, 1867, 1868.

### 3. *Relation of the Scotch glacial fauna to the glacial fauna of Canada.*

The fossil glacial fauna of Canada is not so widely distinct from the living fauna of the Gulf of St. Lawrence as the fossil glacial fauna of the Clyde beds is distinct from the living fauna of the Firth.

In Scotland at least sixteen species are found fossil which are extinct in British waters, together with many Arctic varieties of British species.

In Canada Dr. Dawson has described 205 species of "Post-pliocene fossils," and remarks that "the whole of these, with three or four exceptions, may be affirmed to be living Northern or Arctic species, belonging, in the case of the marine species, to moderate depths, or varying from the littoral zone to—say 200 fathoms. The assemblage is identical with that of the northern part of the Gulf of St. Lawrence and Labrador coast at present, and differs merely in the presence or absence of a few more southern forms now present in the Gulf, especially in its southern part, where the fauna is of a New England type, whereas that of the Post-pliocene may be characterised as Labradorian."<sup>1</sup>

This marked contrast between the Canadian and Scotch glacial fauna in relation to the fauna locally existing proves the greater completeness of the change of climate in Scotland than in Canada.

The Scotch glacial fauna has, moreover, a strong alliance with the Canadian shown by the prevalence in both of very characteristic Arctic species.

Out of thirty-three fossil species of Ostracoda collected from the Post-pliocene beds of Canada and Maine,

23 are found in Scottish glacial beds,

25 live in British waters,

6 are new.

The comparison between the Scotch and Canadian beds is of special interest, since it suggests that at the period when the glacial fauna flourished in the Scottish seas, the climate was nearly the same as that prevailing in Canada during the same epoch, *i. e.* slightly colder than that of the St. Lawrence.

The fossils, however, must not be considered as marking the extreme point of cold reached during that epoch; but rather as indicating the commencement of slightly milder conditions than had hitherto prevailed.

The question suggested by this comparison, therefore, is, What conditions would produce in the Clyde a temperature slightly colder than that of the Gulf of St. Lawrence?

<sup>1</sup> 'Notes on the Post-pliocene Geology of Canada,' by J. W. Dawson, LL.D.; Montreal, 1872; p. 101.

The existence of an Arctic current, the wide expanse of land in the American Arctic regions exercising its chilling influence, and other circumstances connected with the directions of the mountain-ranges and the heights of the water-shed, account to a large extent for the climate of Canada.

A corresponding series of changes would explain *not* the whole phenomena of the glacial epoch, but the existence of the fauna of the glacial clays in Scottish waters. The shiftings of level, of which there is ample evidence, would involve rearrangements in the relative proportions of land and water; while there would be vital alterations in the directions of the Arctic currents, and a deflection in the Gulf Stream.<sup>1</sup>

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<sup>1</sup> See a paper "On the Reason why the Change of Climate in Canada since the Glacial Epoch has been less complete than in Scotland," by James Croll, 'Trans. Geol. Soc. Glasgow,' vol. ii, p. 138. Also a paper "On the Relation between the Glacial Deposits of Scotland and those of Canada," by H. W. Crosskey, F.G.S., *ibid.*, p. 132.



§ VI. THE FOLLOWING IRISH AND ENGLISH POST-TERTIARY DEPOSITS  
HAVE BEEN EXAMINED FOR OSTRACODA.

1. WOODBURN, CARRICKFERGUS.

About a mile and a half north of Carrickfergus a bed of clay has been cut through by the stream both a little above and below Woodburn Bridge. This clay is dark-grey in colour and somewhat stony, and contains a few flint pebbles. It is irregularly overlain by from one to five feet of shingle, which appears to represent the old bed of the river. In this clay we noticed *Leda pernula*, *Leda pygmæa*, with fragments of *Balani*, &c.; and an Arctic character may be assigned to the deposit.

The following Ostracoda were found :

- Cythere pellucida*, Baird.
- *pulchella*, Brady.
- *concinna*, Jones.
- *tuberculata* (G. O. Sars).
- *Dunelmensis* (Norman).
- Cytheridea punctillata*, Brady.
- Cytherura complanata*, n. sp.
- *cellulosa* (Norman).
- Cytheropteron nodosum*, Brady.
- *arcuatum*, n. sp.
- *Montrosiense*, n. sp.
- Bythocythere simplex* (Norman).
- Pseudocythere caudata*, G. O. Sars.
- Paradostoma variabile* (Baird).
- Polycope orbicularis*, G. O. Sars.

## 2. PORTRUSH.

The raised-beach at Portrush consists chiefly of shell débris. Like a large number of the raised beaches the material loses little in washing—only 4 per cent., which passes off in fine mud.

The deposit is uneven in thickness, filling up irregularities of the rock on which it rests. Its area is greatly hidden, but it is possibly 100 yards square. The fauna it contains is entirely recent.

Height above the sea fifteen feet.

The following Ostracoda were found :

*Pontocypris mytiloides* (Norman).

*Cythere viridis*, Müller.

— *tenera*, Brady.

— *pellucida*, Baird.

— *crispata*, Brady.

— *albo-maculata*, Baird.

— *gibbosa*, Brady and Robertson.

— *conveza*, Baird.

— *villosa* (G. O. Sars).

— *pulchella*, Brady.

— *angulata* (G. O. Sars).

— *emarginata* (G. O. Sars).

*Cytheridea punctillata*, Brady.

— *torosa* (Jones).

— *elongata*, Brady.

*Eucythere Argus* (G. O. Sars).

*Loxoconcha impressa* (Baird).

— *tamarindus* (Jones).

— *multifora* (Norman).

*Cytherura nigrescens* (Baird).

— *similis*, G. O. Sars.

— *angulata*, Brady.

— *gibba* (Müller).

— *undata*, G. O. Sars.

- Cytherura cellulosa* (Norman).  
 — *clathrata*, G. O. Sars.  
*Cytheropteron nodosum*, Brady.  
 — *latissimum* (Norman).  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma ensiforme*, Brady.

## 3. BELFAST.

In digging the new docks at Belfast a fossiliferous deposit was passed through, exceedingly rich in Mollusca now living in British seas. We examined for Ostracoda samples of the material taken from the depths beneath the surface of three to four feet, eight feet, twelve to fourteen feet, and twenty feet, and found the following species :

|   | 3 to 4 ft.<br>below<br>surface. | 3 ft.<br>below<br>surface. | 12 to 14<br>ft. below<br>surface. | 20 ft.<br>below<br>surface. |
|---|---------------------------------|----------------------------|-----------------------------------|-----------------------------|
| <i>Pontocypris mytiloides</i> (Norman) .....    | ×                               | ×                          |                                   |                             |
| <i>Cythere pellucida</i> , Baird .....          | ×                               | ×                          | ...                               | ×                           |
| — <i>viridis</i> , Müller .....                 | ×                               | ×                          | ×                                 | ×                           |
| — <i>lutea</i> , Müller .....                   | ×                               | ×                          | ...                               | ×                           |
| — <i>albomaculata</i> , Baird .....             | ×                               |                            |                                   |                             |
| — <i>convexa</i> , Baird .....                  | ×                               | ...                        | ...                               | ×                           |
| — <i>crispata</i> , Brady .....                 | ×                               | ×                          | ×                                 | ×                           |
| — <i>pulchella</i> , Brady .....                | ×                               |                            |                                   |                             |
| — <i>villosa</i> (G. O. Sars) .....             | ×                               | ×                          | ×                                 | ×                           |
| — <i>concinna</i> , Jones .....                 | ...                             | ...                        | ...                               | ×                           |
| — <i>tuberculata</i> (G. O. Sars) .....         | ...                             | ×                          | ×                                 | ×                           |
| — <i>Jonesii</i> (Baird) .....                  | ...                             | var. ×                     | ×                                 | ×                           |
| — <i>antiquata</i> (Baird) .....                | ×                               | ×                          | ×                                 | ×                           |
| — <i>Whitei</i> (Baird) .....                   | ...                             | ×                          |                                   |                             |
| — <i>Dunelmensis</i> (Norman) .....             | ...                             | ...                        | ×                                 |                             |
| <i>Cytheridea elongata</i> , Brady .....        | ×                               |                            |                                   |                             |
| <i>Loxoconcha impressa</i> (Baird) .....        | ×                               | ×                          | ×                                 | ×                           |
| — <i>tamarindus</i> , Jones .....               | ×                               | ...                        | ...                               | ×                           |
| <i>Xestoleberis depressa</i> , G. O. Sars ..... | ...                             | ×                          |                                   |                             |
| — <i>aurantia</i> (Baird) .....                 | ...                             | ...                        | ×                                 |                             |
| <i>Cytherura nigrescens</i> (Baird) .....       | ×                               | ×                          | ×                                 | ×                           |
| — <i>similis</i> , G. O. Sars .....             | ...                             | ...                        | ...                               | ×                           |
| — <i>affinis?</i> G. O. Sars .....              | ...                             | ...                        | ×                                 |                             |
| — <i>striata</i> , G. O. Sars .....             | ×                               | ...                        | ×                                 | ×                           |
| — <i>undata</i> , G. O. Sars .....              | ...                             | ×                          | ×                                 |                             |
| — <i>gibba</i> (Müller) .....                   | ...                             | ...                        | ...                               | ×                           |
| — <i>acuticostata</i> , G. O. Sars .....        | ×                               |                            |                                   |                             |
| <i>Paradoxostoma variabile</i> (Baird) .....    | ...                             | ...                        | ×                                 |                             |
| — <i>ensiforme</i> , Brady .....                | ...                             | ...                        | ×                                 |                             |

## 4. BRIDLINGTON, YORKSHIRE.

This bed (which it is impossible now to examine) was originally described by Prof. John Phillips in the second edition of his work on the 'Geology of the Yorkshire Coast' (1836); and in the third edition of the same work is the subject of an exhaustive discussion.

In material obtained some years ago, when the beds were exposed, the following Ostracoda were found :

- Cythere cribrosa*, n. sp.
- *leioderma*, Norman.
- *villosa* (G. O. Sars).
- *angulata* (G. O. Sars).
- *emarginata* (G. O. Sars).
- *costata*, Brady.
- *tuberculata* (G. O. Sars).
- *concinna*, Jones.
- *globulifera*, Brady.
- *mirabilis*, Brady.
- *Dunelmensis* (Norman).
- Cytheridea papillosa*, Bosquet.
- *elongata*, Brady.
- *punctillata*, Brady.
- *Sorbyana*, Jones.
- Cytherura clathrata*, G. O. Sars.
- Cytheropteron nodosum*, Brady.
- *angulatum*, Brady and Robertson.
- Paradoxostoma ensiforme*, Brady.
- *pyriforme*, n. sp.
- Sclerochilus contortus* (Norman).

## 5. HOPTON CLIFF, NEAR YARMOUTH.

This deposit has been described as "Middle Glacial" by Messrs. S. V. Wood, jun., and F. W. Harmer, in the Palæontographical Society's volume for 1871, p. 22. The

Ostracoda obtained from the material submitted to us presented a general Arctic character, varied by one or two Tertiary forms, and were greatly worn.

The following Ostracoda were found :

- Cythere albomaculata*, Baird.
- *cicatricosa*, Reuss.
- *villosa* (G. O. Sars).
- *macropora*, Bosquet.
- *latimarginata*, Speyer.
- *tuberculata* (G. O. Sars).
- *Hoptonensis*, n. sp.
- Cytheridea elongata*, Brady.
- Cytherura nigrescens* (Baird).
- Cytheropteron nodosum*, Brady.
- *Montrosiense*, n. sp.
- Asterope teres* (Norman).

## 6. HORNSEA.

The beds at Hornsea have been described in a paper "On the Glacial and Post-glacial Structure of Lincolnshire and South-east Yorkshire," by Searles V. Wood, jun., Esq., F.G.S., and the Rev. J. L. Rowe, F.G.S.<sup>1</sup>

In the material submitted to us the following Ostracoda were found :

### 1. In the lower freshwater bed—

- Cypris compressa*, Baird.
- *gibba*, Ramdohr.
- *reptans* (Baird).
- Cypridopsis obesa*, Brady and Robertson.
- Candona albicans*, Brady.
- *lactea*, Baird.
- *candida* (Müller).
- Limnocythere inopinata* (Baird).
- Cytheridea lacustris* (G. O. Sars).

<sup>1</sup> 'Quart. Journal of Geol. Soc.,' vol. xxiv, p. 146.

## 2. In the upper bed—

*Cypris reptans* (Baird).

— *gibba*, Ramdohr.

*Cypridopsis obesa*, Brady and Robertson.

*Candona detecta* (Müller).

## 7. CARDIFF—NEW DOCK BASIN.

This deposit is of an estuarine character, becoming more marine in its lower portions. We examined separately portions of the clay taken from eight, fifteen, twenty, thirty, and forty feet below the surface. It varies little in composition, although it alters in colour from brownish to dark grey, but at the depth of forty feet it alternates with beds of gravel to the depth of sixty-four feet, where it reaches a red marl.

At eight feet below the surface the dry clay consists of 96 per cent. fine mud, 4 per cent. shell *débris* and fine sand.

At forty feet, 94 per cent. fine mud, 6 per cent. fine and coarse sand, with a few fragments of shells and a small portion of vegetable matter. The deposit contains some freshwater and brackish, as well as marine, forms,—a fact accounted for by its position at the mouth of the River Taff.

The prevailing species is *Scrobicularia piperata*, the characteristic shell of the Mersey and the Montrose estuarine muds. It ranges from top to bottom of the clay, and, in some places, lies in bands with little admixture of clay.

Although the whole fauna has an estuarine character, it is more diversified and more decidedly marine towards the bottom. The alternations, however, are so capricious that no lines of regular change can be drawn in the fauna. For example, at forty feet below the surface *Cythere porcellanea* prevails over *Cythere castanea*; at fifteen feet *C. castanea* prevails over *C. porcellanea*; at eight feet *C. porcellanea* prevails over *C. castanea*.

At the depth of forty feet the shells of Ostracoda and those of young Mollusca are filled with iron-pyrites. This is also the case at eight feet below the surface; but at the intermediate depths of fifteen, twenty, and thirty feet scarcely a trace of it is seen.

The following Ostracoda were found :

- Candona lactea*, Baird.
- Cypris ovum* (Jurine).
- Pontocypris mytiloides* (Norman).
- Potamocypris fulva*, Brady.
- Cythere castanea*, G. O. Sars.
- *porcellanea*, Brady.
- *tenera*, Brady.
- *tuberculata* (G. O. Sars).
- Cytheridea torosa* (Jones).
- Eucythere Argus* (G. O. Sars).
- Loxoconcha elliptica*, Brady.
- Xestoleberis aurantia* (Baird).
- *depressa*, G. O. Sars.
- Cytherura producta*, Brady.
- *angulata*, Brady.
- *striata*, G. O. Sars.
- *quadrata*, Norman.
- *cellulosa* (Norman).
- Cytheropteron rectum*, Brady.
- Schlerochilus contortus*, var. *abbreviatus*.
- Paradoxostoma flexuosum*, Brady.
- *abbreviatum*, G. O. Sars.
- *ensiforme*, Brady.
- *Fischeri*, G. O. Sars.

#### 8. MERSEY, LIVERPOOL.

The following series of beds has been described :<sup>1</sup>

- |  |               |
|--|---------------|
| 1. Surface soil                          | about 2 ft.   |
| 2. Sandy silt (probably fresh water)     | at most 6 in. |
| 3. Freshwater bed (with numerous shells) | 4 to 18 in.   |

<sup>1</sup> "Observations on the Geology of the Cheshire Coast," by Charles Potter, 'Trans. of Liverpool Geol. Soc.,' 1868-9.

4. Sandy silt (probably fresh water) . . . . . 9 in.
5. Peat bed.
6. Silt or bluish clay, with *Scrobicularia piperata*,  
    *Rissoa parva*, &c. and Ostracoda . . . . . 8 ft.
7. Peat bed.
8. Boulder-clay.

In the silt or bluish clay, with *Scrobicularia piperata* (6), the following Ostracoda were found :

*Cythere pellucida*, Baird.  
     — *tenera*, Brady.  
*Loxoconcha impressa* (Baird).  
*Cytherura nigrescens* (Baird).  
     — *similis*, G. O. Sars.  
     — *angulata*, Brady.  
*Sclerochilus contortus* (Norman).  
*Paradoxostoma abbreviatum*, G. O. Sars.

#### 9. BRANSTON FEN, LINCOLNSHIRE.

In some Post-tertiary clay from this fen the following species of Ostracoda were found :

*Cypris compressa*, Baird.  
     — *gibba*, Ramdohr.  
*Cypridopsis obesa*, Brady and Robertson.  
*Candona detecta* (Müller).  
     — *lactea*, Baird.  
     — *candida* (Müller).  
*Limnocythere inopinata* (Baird).  
*Cytheridea lacustris* (G. O. Sars).



## 10. WHITTLESEA.

In an old lacustrine deposit at Whittlesea (Cambridgeshire), which is overlaid by five or six feet of marl, the following Ostracoda were found :

- Cypris ovum* (Jurine).
- *lævis*, Müller.
- *gibba*, Ramdohr.
- *reptans* (Baird).
- Cypridopsis Newtoni*, Brady and Robertson.
- Candona albicans*, Brady.
- *lactea*, Baird.
- *compressa* (Koch).
- *candida* (Müller).
- Darwinella Stevensoni*, Brady and Robertson.

## 11. CHESTER.

Mr. Shone, jun., forwarded to us Ostracoda from the "Upper Boulder clay" (described by Mr. McIntosh) of Chester. They proved to belong to the following species :

- Cythere tuberculata* (G. O. Sars).
- *antiquata* (Baird).
- *Dunelmensis* (Norman).
- *Jonesii* (Baird).
- Eucythere Argus* (G. O. Sars).
- Cytherura angulata*, Brady.
- Loxoconcha impressa* (Baird).
- *tamarindus* (Jones).
- Cytheropteron nodosum*, Brady.
- Paradoxostoma flexuosum*, Brady.

## § VII. CLASSIFICATION OF THE OSTRACODA.

The remains of Entomostraca occurring in the Post-tertiary formations belong, so far as we at present know them, exclusively to the Ostracoda, nor is it likely that an extension of our knowledge will reveal the presence of any other tribes in the British area. The soft or chitinous nature of the investments of the other groups renders their speedy putrefaction almost inevitable, except, perhaps, with some of the Phyllopoda, which are for the most part confined to warmer waters than any which have existed in this region in recent times.<sup>1</sup>

The only satisfactory classification of these creatures being based upon the structure of those parts which most rapidly disappear after the death of the animal, it would be of little use in this place to give tables which must refer only to details altogether beyond the scrutiny of the palæontologist. We may, however, refer the reader for information on this subject to the memoir of Dr. G. O. Sars on the 'Marine Ostracoda of Norway,' and to Mr. G. S. Brady's 'Monograph of the Recent British Ostracoda,' published by the Linnean Society. But as being of more utility to the student of fossil species we have drawn up a table embracing only the characters derived from the shells without any regard to internal animal structure; this is the more feasible inasmuch as the affinities of internal anatomy are always found (as might, by a believer in the doctrine of evolution, be fully expected) to correspond more or less closely with similar affinities of shell-structure. To make our survey of the Ostracoda more complete, and for the sake of assigning to their proper position several genera, which have hitherto been published only in a disconnected manner, we, however, here insert a synopsis of the anatomical characters of the species belonging to the families Cypridæ, Darwinellidæ, and Cytheridæ; and we give likewise a list, revised up to this date, of the families and genera of the Ostracoda, recent and fossil, so far as they are known to us.

<sup>1</sup> The only instance within our knowledge in which remains of Cladocera have been preserved in the Post-tertiary formations is that of the Dipple Tile-works, referred to on a previous page. Fragments of the chitinous limbs and investments of these creatures are here very abundant, and possibly, if they could be examined *in situ*, might be found tolerably perfect, but the unavoidable processes of "washing," and otherwise manipulating the matrix, reduce them to a very fragmentary condition before they can be effectively submitted to microscopic examination. We have, however, been able to recognise with certainty in the Dipple deposit, remains of *Camptocercus macrourus* (which constitute the bulk of the fragments), and *Alona elongata*, and, more doubtfully, *Chydorus sphaericus*, *Alona guttata*, and *Alona quadrangularis*. There are also in considerable abundance bodies which appear to be the ephippia of *Daphniadæ*.

## GENERA OF RECENT AND POST-TERTIARY OSTRACODA.

*Class* CRUSTACEA.*Subclass* ENTOMOSTRACA.*Order* GNATHOSTOMATA.*Legion* LOPHYROPODA.*Tribe* OSTRACODA.*Section* PODOCOPA.*Family* 1.—CYPRIDÆ.*Genus* Cypris.

Cypridopsis.

Paracypris.

Aglaia.

Notodromas.

Candona.

Potamocypris.

Goniocypris.

Pontocypris.

Argilloëcia,

Bairdia.

Macrocypris.

*Family* 2.—DARWINELLADÆ.*Genus* Darwinella.*Family* 3.—CYTHERIDÆ.*Genus* Cythere.

Limnocythere.

Metacypris.

Cytheridea.

Eucythere.

Krithe.

Loxoconcha.

Xestoleberis.

Cytherura.

Sarsiella.

Cytheropteron.

*Genus* Bythocythere.

Pseudocythere.

Cytherideis.

Sclerochilus.

Xiphichilus.

Paradoxostoma.

*Section* MYODOCOPA.*Family* 4.—CYPRIDINADÆ.*Genus* Cypridina.

Bradycinetus.

Philomedes.

Eurypylus.

Asterope.

*Family* 5.—ENTOMOCONCHIDÆ.*Genus* Heterodesmus.*Family* 6.—CONCHÆCIADÆ.*Genus* Conchœcia.

Halocypris.

*Section* CLADOCOPA.*Family* 7.—POLYCOPIDÆ.*Genus* Polycope.*Section* PLATYCOPA.*Family* 8.—CYTHERELLIDÆ.*Genus* Cytherella.Bosquetia (*incertæ sedis*).

## OSTRACODA—CHARACTERS OF CARAPACE.

|                          | SHAPE AS SEEN Laterally.  | Texture and Markings of Shell.  | HingeMENT.   |
|--------------------------|---|---|--|
| <b>CYPRIDÆ—</b>          |   |   |  |
| <i>Cypris</i> .....      | Usually reniform or subreniform, valves equal or subequal   | Fragile, usually more or less translucent, smooth, or hispid, often slightly punctate, rarely toothed at the lower angles | Consisting of feebly overlapping flanges.  |
| <i>Cypridopsis</i> ..... | Like <i>Cypris</i> , but higher in proportion to length, and smaller  | Like <i>Cypris</i> , but commonly hispid  | Like <i>Cypris</i> .   |
| <i>Potamocypris</i> ...  | Like <i>Cypridopsis</i> , but with right valve much larger than left  | Like <i>Cypridopsis</i> , but with a more robust and calcareous shell   | Simple.  |
| <i>Paracypris</i> .....  | Much elongated, compressed, highest in front  | Moderately robust, smooth and polished, destitute of sculpture  | Simple.  |
| <i>Aglaia</i> .....      | Oblong, subreniform, compressed, nearly equal in height throughout  | As in <i>Paracypris</i>   | Simple.  |
| <i>Notodromas</i> ...    | Subquadangular, very high in proportion to length, male and female very different in shape  | Like <i>Cypris</i>  | Simple, contact-margins (ventral), overlapping, that of the (female) left valve having a conspicuous flattened tooth-like plate at the posterior extremity, articulating with a fossa in the opposite valve. |
| <i>Candona</i> .....     | Elongated, subreniform  | Like <i>Cypris</i>  | Simple, rarely with a prominent curved process near posterior termination of left valve.   |
| <i>Pontocypris</i> ..... | Subtriangular or subreniform, usually higher in front than behind   | Thin and fragile, with little or no sculpture, more or less hispid  | Simple.  |
| <i>Argillœcia</i> .....  | Compressed, oblong, suboval   | Moderately robust, smooth   | Simple.  |
| <i>Bairdia</i> .....     | Subtriangular or subrhomboidal, highest near the middle, height great in proportion to length, left valve larger than right and overlapping | Moderately robust, smooth or only moderately pitted, sometimes toothed on anterior and posterior margins                  | Flexuous, formed by the strongly overlapping border of the left valve.   |

|                      | SHAPE AS SEEN Laterally.   | Texture and Markings of Shell.  | HingeMENT.  |
|----------------------|--|---|---|
| <b>CYPRIDÆ—</b>      |  |   |   |
| Macrocypris ...      | Elongated, attenuated behind, subtriangular, right valve larger than left, and overlapping | Robust, perfectly smooth  | Flexuous, formed by the overlapping right valve.  |
| Goniocypris ...      | Triangular, height and length about equal, minute  | Very thin and fragile, almost structureless   | Simple.   |
| <b>DARWINELLADÆ—</b> |  |   |   |
| Darwinella .....     | Compressed, oblongo-ovate or subcuneate, valves unequal, right much larger than left       | Thin, quite smooth, pellucid  | Simple.   |
| <b>CYTHERIDÆ—</b>    |  |   |   |
| Metacypris .....     | Subrhomboidal, supero-posterior angle produced   | Moderately robust, closely punctate   | On right valve, by a laminated angular process in front, behind by a strong flange with a single tooth, the flange continued round posterior margin, on left valve by a deep sulcus behind and a shallow one in front.        |
| Limnocythere ...     | Reniform or subreniform  | Moderately robust, angularly pitted, prominently tuberculated or spinous  | Simple, or with a very feebly marked arrangement, as in the next genus.   |
| Cythere .....        | Subreniform or subquadrate, mostly highest in front  | Robust, often excessively thick and calcareous, smooth or variously sculptured with fine punctations or large and deep fossæ, tubercles, spines, elevated ridges, &c. | Two strong teeth on the right, with corresponding depressions on the left valve, between the teeth often a strong longitudinal bar and between the fossæ a furrow, left valve sometimes with a small tooth behind each fossa. |
| Cytheridea .....     | Subtriangular or triangularly ovate, highest in front of the middle                        | Usually thick and strong, smooth, or more commonly foveolate; sometimes concentrically rugose, with dentate margins   | Two series of terminal crenulated tubercles on right, with corresponding depressions of left valve; intermediate portions either plain or tuberculated on left and indented on right valve.                                   |
| Eucythere .....      | Subtriangular, high and rounded in front, depressed behind                                 | Thin and pellucid, bearing conspicuous rounded papillæ  | Formed on right valve by a projecting crest, on left by a corresponding depression.   |
| Krithe .....         | Subovate, oblong, truncate behind  | Smooth, with small distant papillæ  | Like <i>Eucythere</i> , but feebly developed.   |

|                   | SHAPE AS SEEN Laterally.  | Texture and Markings of Shell.   | HingeMENT.   |
|-------------------|---|--|--|
| <b>CYTHERIDÆ—</b> |   |  |  |
| Cytherideis ..... | Elongated, subovate, depressed in front, right valve overlapping in centre of ventral margin  | Smooth, more or less finely punctate   | Nearly simple.   |
| Xestoleberis..... | Subtriangular, higher behind than in front  | Smooth and polished, with distant round papillæ  | A dentated projecting crest of the left articulating with an excavation of the right valve.                    |
| Loxoconcha.....   | Subrhomboidal or "peach-stone shaped"   | Smooth and sparingly papillose, or concentrically pitted   | Two small terminal teeth on each valve, intervening portion often finely crenulated.                           |
| Bythocythere ...  | Subrhomboidal or fusiform, with hinder margin produced into a distinct beak   | Smooth or ornamented with small rounded pittings and papillæ, often obscurely reticulated and having a transverse median fissure | Simple, or composed of a slight bar and furrow; no teeth.  |
| Cytheropteron...  | Subrhomboidal, more or less beaked behind, rounded in front, usually produced laterally towards ventral margin into a wing-like projection; valves unequal and dissimilar | More or less pitted; the pits usually subquadrangular and arranged in transverse rows; usually with a transverse median furrow   | Two small terminal teeth on right valve with opposing fossæ and an intervening crenulated ridge on left valve. |
| Pseudocythere...  | Obliquely quadrangular, rounded in front, obliquely truncate behind, and produced into a blunt beak at supero-posteal angle   | Very thin and fragile, smooth, almost structureless  | Simple.  |
| Cytherura .....   | Oblong or subtriangular, usually minute, produced behind into a more or less prominent beak, valves dissimilar and unequal  | Smooth, or variously marked with reticulated, ribbed, or punctate ornament, usually robust                                       | Hinge-processes obsolescent or altogether wanting.   |
| Sarsiella .....   | Almost circular, rostrate behind (?), much compressed   | Exceedingly rugose, with circular fossæ in the interspaces   | —  |
| Sclerochilus ...  | Elongated, flexuous, bean-shaped  | Smooth and polished, very hard   | Projecting median crest of left valve.   |
| Xiphichilus ..... | Valves subequal, compressed, elongated, pointed at both ends, ventral margins much compressed   | Thin and fragile, smooth, polished, marked at margins with transverse hair-like lines  | Simple.  |

|  | SHAPE AS SEEN Laterally.   | Texture and Markings of Shell.  | HINGEMENT.   |
|--|--|---|--|
| <b>CYTHERIDÆ—</b><br>Paradoxostoma       | Elongated, compressed, usually higher behind than in front; usually subovate, subtriangular, or flexuous | Thin, fragile, polished, and devoid of sculpture, but often marked with arborescent coloured patches of black, olive, or violet hue | Simple.  |
| <b>CYPRIDINADÆ—</b><br>Cypridina .....   | Subcircular or very broad oval, with a distinct beak and notch in front and a slight projection behind   | Smooth, thin, and flexible  | Nearly simple.   |
| Bradycinetus ...                         | Similar to the foregoing, beak and notch well developed  | Dense, punctate   | Nearly simple.   |
| Philomedes .....                         | Similar to the above, posterior extremity usually with one or two spines                                 | Moderately strong, punctate, or foveate and ribbed  | Nearly simple.   |
| Asterope .....                           | Elongated, beak not at all produced, posterior extremity evenly rounded                                  | Moderately strong, smooth   | Nearly simple.   |
| Eurypylus .....                          | Beak obsolete, no distinct notch; seen from above widest in front  | Robust, more or less pitted   | —  |
| <b>POLYCOPIDÆ—</b><br>Polycope .....     | Circular or nearly so, no notch or beak  | Thin, calcareous, smooth, punctate, or reticulate   | Formed by a slight overlapping of the valves.                            |
| <b>CYTHERELLIDÆ—</b><br>Cytherella ..... | Usually elliptical, compressed, valves very unequal, the right much the larger                           | Thick and dense, smooth or variously sculptured   | A groove on the right valve into which the edge of the left is received. |
| Bosquetia .....                          | Obliquely and broadly ovate, right valve much larger than left, and overlapping both above and below     | Very thick and hard, smooth   | Formed by an overlapping (!) of the right valve at each extremity.       |

Though we have thought it desirable to give these brief generic diagnoses, inserting only such characters as may be derived from the formation of the carapace (this being the only part of the animal available to the palæontologist); it should, nevertheless, be clearly understood that the really important generic distinctions are, in almost all cases, based upon the structure of the internal organs, chiefly, indeed, on the formation of the limbs, mouth-apparatus, and sexual organs. Yet, in the majority of cases, these deep-seated peculiarities coincide so remarkably with a particular form of shell that there need usually be no difficulty in assigning the fossil remains met with in the Tertiary and Post-tertiary strata to their proper genera. Amongst the Entomostraca of the Palæozoic formations, however, we meet with types of shell-structure far removed from those of recent times and can only vaguely conjecture as to their relations.

From the foregoing Table we have excluded altogether the family Conchoeciadæ, the delicate valves of which have not been found (nor, indeed, are they likely ever to be found) in any geological formation. The exclusively Palæozoic genera are also omitted, as well as the recent genus *Heterodesmus*, which has not been met with except in the Chinese seas, and seems to be allied to the Carboniferous genus *Entomoconchus*.

OSTRACODA—*Synopsis of Genera based upon the anatomical characters of the animal.*

|          |  |  |  |  |
|----------|--|--|--|--|
| CYPRIDÆ. | Second pair of jaws.                     | Possessing a branchial appendage; palp subconical, indistinctly jointed, ending in three setæ. | bearing a brush of setæ. Setæ of the upper antennæ very long. Post-abdominal rami  | { well developed, terminating in two strong curved claws . . . . . } <i>Cypris</i> .*  |
|          |  |  |  | { rudimentary, setiform . . . . . } <i>Cypridopsis</i> .   |
|          | destitute of a branchial appendage. Palp |  | without a brush of setæ. Setæ of the upper antennæ very short. Post-abdominal rami | { rudimentary . . . . . } <i>Potamocypris</i> .  |
|          |  |  |  | { well-developed, terminating in two strong curved claws. First and second pairs of feet } alike . . . <i>Paracypris</i> .             |
|          |  |  |  | { } dissimilar . . . <i>Aglaia</i> .   |
|          |  |  | subconical, indistinctly jointed. Setæ of lower antennæ                            | { long, reaching beyond the apex of the terminal claws. Two eyes . . . . . } <i>Notodromas</i> .                                       |
|          | distinctly jointed, subpediform          |  |  | { altogether wanting. One eye . . . . . } <i>Candona</i> .   |
|          |  |  | 3-jointed; upper antennæ   | { elongated, 7-jointed, armed with long setæ . . . } <i>Pontocypris</i> .  |
|          |  |  |  | { short and robust; 5-jointed; in the female shortly setose, in the male provided with a few long setæ . . . . . } <i>Argillæcia</i> . |
|          |  |  | 4-jointed; upper antennæ shortly setose. Postabdominal rami                        | { largely developed, terminating in several long setæ . . . . . } <i>Bairdia</i> .   |
|          | Animal unknown                           |  |  | { rudimentary . . . . . } <i>Macrocypris</i> .   |
|          |  |  |  | . . . . . <i>Gonocypris</i> .  |

\* With this genus we incorporate *Cypris* (Zenker) and *Chlamydotheca* (Saussure).



|  |  |  |  |  |   |  |   |                       |  |
|--|--|--|--|--|---|--|---|-----------------------|--|
| DARWIN-ELLIDÆ  | Antennæ destitute of swimming setæ, and of poison gland and duct. Mandible-palp 3-jointed, the basal joint large and densely setiferous. Two pairs of jaws, first with a large branchial plate, second with a smaller branchial plate and a pediform palp. Two pairs of feet external to the valves. Postabdominal lobes subconical, small . . . . . |  |  |  |   | <i>Darwinella.</i>   |   |                       |  |
|  |  |  |  |  |   |  |   |                       |  |
| CYTHERIDÆ.   | Mouth provided with a lip and labrum. Masticatory organs well developed. Mandibles toothed at the lower extremity.   | Lower antennæ 4-jointed. Upper antennæ | 5-jointed; last three joints   | elongated, their united lengths more than that of the preceding joint;                         | destitute of spines; bearing only a few short slender setæ . . . . .  | <i>Limnocythere.</i>   |   |                       |  |
|  |  |  |  |  |   | more or less strongly spiniferous. Feet in the male and female | alike. Internal lobe of the first pair of maxillæ { well developed. <i>Cythere.</i><br>rudimentary . <i>Eucythere.</i>  |                       |  |
|  |  |  |  |  | dissimilar; right foot of first pair in the male prehensile, right of the second pair very weak and rudimentary . . . . . |  |   | <i>Cytheridea.</i>    |  |
|  |  |  |  |  |   |  | short and stout, their united length shorter than that of the preceding joint, bearing long curved spines. First two pairs of feet only 3-jointed. Right foot of last pair in the male prehensile. Eyes wanting . . . . . |                       |  |
|  |  |  |  | short, their united length equal to that of preceding joint, bearing short setæ only . . . . . |   |  | <i>Cytherideis.</i>   |                       |  |
|  |  |  |  | 6-jointed; beset with simple setæ; last four joints  | short and gradually decreasing in length . . . . .  |  |   | <i>Xestoleberis.</i>  |  |
|  |  |  | of moderate length, unequal, penultimate the longest . . . . .   |  |   |  | <i>Metacypria.</i>  |                       |  |
|  |  |  | mostly much elongated and slender; unequal . . . . .   |  |   |  | <i>Loxococoncha.</i>  |                       |  |
|  |  |  | 7-jointed; first two joints very large and stout, last five slender and bearing moderately long setæ . . . . . |  |   |  |   | <i>Bythocythere.</i>  |  |
|  |  |  | Lower antennæ 5-jointed. Upper antennæ   | 6-jointed; last four joints  | 5-jointed; beset with short scattered hairs. Postabdominal lobes broad and short, bearing three setæ. No eyes . . . . .   |  |   | <i>Cytheropteron.</i> |  |
|  | much narrower than the preceding, and bearing scattered short hairs, which are in part spiniform. Postabdominal lobes rudimentary, destitute of hairs. Two separate eyes . . . . .   |  |  |  | <i>Cytherura.</i>   |  |   |                       |  |
|  | not narrower than the preceding, and beset towards the apex with numerous long setæ. Postabdominal lobes larger than ordinary, bipartite, and bearing five setæ. One eye . . . . .   |  |  |  | <i>Sclerochilus.</i>  |  |   |                       |  |
|  | 7-jointed, bearing numerous very long setæ, last joint very long and slender; two basal joints large and stout. Postabdominal lobes subconical, directed downwards, and bearing three hairs. Eyes wanting . . . . .  |  |  |  | <i>Pseudocythere.</i>   |  |   |                       |  |
|  | Animal unknown . . . . .   |  |  |  |   |  | <i>Sarsiella.</i>   |                       |  |
| Mouth simple, tubiform; its orifice surrounded by a circular disk situated at the apex of a large subconical protuberance. Organs of mastication poorly developed and weak. Mandibles styliform; palp very narrow, destitute of a branchial appendage. First pair of jaws composed of narrow and partly imperfect lobes. Inferior antennæ, 5-jointed; upper, 6-jointed |  |  |  |  | very slender and sparingly setose . . . . .<br><br>excessively slender and quite destitute of setæ . . . . .              |  | <i>Paradoxostoma.</i><br><br><i>Xiphichilus.</i>  |                       |  |

## § VIII. SUMMARY OF FACTS OF DISTRIBUTION.

1. *Freshwater and Marine Species*.—Of the one hundred and thirty-two species of Ostracoda described in this Monograph, twenty-four may be considered to have been inhabitants of fresh or slightly brackish water, the remaining one hundred and eight being strictly marine species. The freshwater group is constituted as follows :

|                      |                        |
|----------------------|------------------------|
| Cypris cinerea.      | Candona compressa.     |
| — compressa.         | — detecta.             |
| — gibba.             | — lactea.              |
| — ovum.              | Potamocypris fulva.    |
| — reptans.           | Darwinella Stevensoni. |
| — salina.            | Limnocythere antiqua.  |
| — virens.            | — inopinata.           |
| — lævis.             | — monstifica.          |
| Cypridopsis Newtoni. | — Sancti-Patricii.     |
| — obesa.             | Cytheridea lacustris.  |
| Candona albicans.    | — torosa.              |
| — candida.           | Loxoconcha elliptica.  |

Of these twenty-four species all except one (*Limnocythere antiqua*, respecting which we entertain some doubt as to whether it may not be a sexual variation or a stage of growth of some other species) are perfectly familiar to us as inhabiting at the present time the freshwater ponds and rivers or the brackish littoral pools of Great Britain and parts of the European continent. Two of them seem to be much restricted in their distribution, and have been found fossil only in the neighbourhood of the localities where they still live : these are *Cypridopsis Newtoni* and *Darwinella Stevensoni*. The presence of *Cytheridea torosa* or *Loxoconcha elliptica* may be taken as an almost certain indication of more or less brackish water ; it is seldom that either species is found living in quite fresh or in undiluted sea-water.

The distribution of the marine species is, however, much more perfectly known : their number being so much greater, and the area over which they have been studied so much wider, we are thus better able to recognise in their distribution the effects of climate and other physical conditions. A comparison of the Ostracodal fauna of the Scottish glacial clays with that of the seas at present washing the European shores leads

us to conclude that the general character of the glacial Ostracoda is of a type decidedly more boreal in character than that of the present epoch in the same latitudes. Perhaps, indeed, we should not be far wrong in saying that the species found in the clay beds of the south of Scotland correspond very closely with what we should expect to find now living on the Atlantic sea-bed between Scotland and Greenland. It is, however, only from very fragmentary observations made by private effort over the latter area that we are able to draw this conclusion; and we, therefore, the more regret that the splendid opportunities of research which were within our grasp, during the cruises of the "Lightning" and "Porcupine," seem to have been in this department almost or entirely neglected. Amongst the contents of the clay beds here referred to we are able, nevertheless, to point to the following species as extending southward, at the present day, only to latitudes corresponding to those of the Northern Hebrides, and apparently reaching their full development only towards the Arctic regions, or on the western side of the Atlantic, in the cold waters of Canada.

2. *List of Post-Tertiary Species now known as characterizing the Arctic seas and the northern coasts of Norway, Scotland, and America.*

|                    |                         |
|--------------------|-------------------------|
| Cythere leioderma. | Cytheridea Sorbyana.    |
| — costata.         | Cytheropteron inflatum. |
| — mirabilis.       | — angulatum.            |
| — latimarginata.   |                         |

*Cytheridea papillosa*, *C. punctillata*, and *Cythere concinna*, though extending somewhat further southward, and living even abundantly on the eastern shores of England, so far south as Yorkshire, are still conspicuously absent from more southern latitudes. These three species are, perhaps, in numbers, the most abundant of all the glacial Ostracoda. On the other hand, certain species, such as *Bairdia inflata*, *B. acanthigera*, and *Cythere emaciata*, which now are found living most abundantly on the southern shores of the British Islands, becoming rare or altogether absent from the northern shores, are likewise either entirely absent or of extreme rarity in the glacial clays; nor, indeed, have we found in these clays any species of distinctly southern type. So far, however, as our present limited knowledge of the English Post-tertiary beds extends, it would seem that their fauna indicates at least as much difference between them and the corresponding Scottish deposits, as exists at present in the seas of the two districts. Of the species comprised in this Monograph nineteen are either extinct or have not yet been seen living. They are as follows:

3. *List of Post-Tertiary Species now extinct, or unknown in the living state.*

|                       |                             |
|-----------------------|-----------------------------|
| Bairdia Cambrica.     | Krithe glacialis.           |
| Aglaia cylindrica.    | Cytherura compressa.        |
| Cythere cribrosa.     | — complanata.               |
| — Cluthæ.             | Cytheropteron Montrosiense. |
| — Logani.             | Bythocythere elongata.      |
| — deflexa.            | Cytherideis subspiralis.    |
| — macropora.          | Paradoxostoma tenerum.      |
| — Hoptonensis.        | — pyriforme.                |
| Limnocythere antiqua. | Bosquetia robusta.          |
| Cytheridea inornata.  |                             |

Comparing the British Post-tertiary Ostracoda, so far as we at present know them, with those recorded by the late Professor Sars and Dr. G. O. Sars,<sup>1</sup> and by Messrs. Crosskey and Robertson,<sup>2</sup> as occurring in the Glacial and Post-glacial beds of Norway, we find that of the forty-five Norwegian species all, except eight (marked \* in the following list), occur likewise in the British deposits of similar date; while of these eight, *Cytherura atra* is altogether unknown to us, and it is just possible that we may have included forms strictly referable to it under some other species of that difficult genus. *Cythere truncata* has not yet been described by G. O. Sars, and may very probably be identical with some other species described in this Monograph. Of these forty-five species (leaving *C. truncata* and *C. atra* as doubtful), *Krithe glacialis* is the only one which is absent from the recent marine fauna of Norway and Great Britain, and we may add that *Cythere albomaculata*, a species very abundant and characteristic of the British recent and fossil faunæ, appears to be almost or entirely absent from those of Norway.

4. *List of Ostracoda found in the Glacial and Post-Glacial deposits of Norway.*

|                         |                   |
|-------------------------|-------------------|
| Paracypris polita.      | Cythere crispata. |
| Pontocypris mytiloides. | * — borealis.     |
| Cythere viridis.        | — villosa.        |
| — lutea.                | — angulata.       |
| — pellucida.            | — emarginata.     |

<sup>1</sup> 'Om de i Norge forekommende fossile Dyrelevninger fra Quartærperioden, et Bidrag til vor Faunas Historie, af Dr. phil. et med. Michael Sars.' Christiania, 1865.

<sup>2</sup> See "Notes on the Post-tertiary Geology of Norway," by Henry W. Crosskey, F.G.S., and David Robertson, F.G.S. 'Trans. Phil. Soc. Glasgow,' 1868.

*Cythere* *Finmarchica*.  
 — *cuneiformis*.  
 — *concinna*.  
 — *tuberculata*.  
 \* — *crenulata*.  
 — *Dunelmensis*.  
 \* — *truncata*.  
*Cytheridea* *papillosa*.  
 — *elongata*.  
 — *punctillata*.  
 — *Sorbyana*.  
*Eucythere* *Argus*.  
*Krithe* *Bartonensis*.  
 — *glacialis*.  
*Loxoconcha* *tamarindus*.  
 — *impressa*.  
*Xestoleberis* *aurantia*.  
 — *depressa*.

*Cytherura* *nigrescens*.  
 \* — *affinis*.  
 \* — *atra*.  
 \* — *lineata*.  
 — *striata*.  
 — *undata*.  
 — *gibba*.  
 — *angulata*.  
 — *acuticostata*.  
 — *cellulosa*.  
*Cytheropteron* *latissimum*.  
 — *nodosum*.  
 \* — *punctatum*.  
 \* — *alatum*.  
 — *Montrosiense*.  
*Sclerochilus* *contortus*.  
*Paradoxostoma* *variabile*.

5. The glacial deposits of Canada, though imperfectly known to us, afford another opportunity of comparison, the following list comprising all that we have noted from that country :

• \* *Cythere* *leioderma*.  
 • \* — *lutea*.  
 — *MacChesneyi*.  
 • \* — *emarginata*.  
 • \* — *concinna*.  
 — *Dawsoni*.  
 • \* — *limicola*.  
 • \* — *globulifera*.  
 — *Logani*.  
 — *cuspidata*.  
 • \* — *Dunelmensis*.  
 • \* *Cytheridea* *papillosa*.  
 • \* — *punctillata*.  
 \* — *cornea*.  
 • \* — *Sorbyana*.  
 — *Williamsoniana* ?  
 (Bosquet).

• \* *Eucythere* *Argus*.  
 • \* *Loxoconcha* *granulata*.  
 • \* *Xestoleberis* *depressa*.  
 • \* *Cytherura* *nigrescens*.  
 • \* — *Sarsii*.  
 — *cristata*.  
 • \* — *striata*.  
 — *granulosa*.  
 • \* — *undata*.  
 • \* — *Robertsoni*.  
 • \* *Cytheropteron* *latissimum*.  
 • \* — *nodosum*.  
 — *complanatum*.  
 • \* — *inflatum*.  
 • \* — *angulatum*.  
 • \* *Sclerochilus* *contortus*.  
 • \* *Paradoxostoma* *variabile*.

Species marked with an asterisk occur living in the British seas, and those marked with a dot in the British Post-tertiary clays. *Cythere Dawsoni* has occurred living in the River St. Lawrence, while *C. MacChesneyi*, *C. cuspidata*, *Cytherura cristata*, *C. granulosa*, and *Cytheropteron complanatum* have not been found at all in other localities, either living or fossil. So that it is evident from the very partial investigation hitherto made that a considerable admixture of species, unknown to Europe, occurs in the Post-tertiary deposits of North America, and that these correspond more or less closely with the recent fauna of the same district. This subject will, however, be found treated at greater length in a paper on "Fossil Ostracoda from the Post-Tertiary Deposits of Canada and New England," published in the 'Geological Magazine' for February, 1871.

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## § IX. DESCRIPTION OF SPECIES.

*Family 1.—CYPRIDÆ.**Genus 1.—CYPRIS, Müller.*

Valves mostly subreniform or elongate-oval, horny in texture. Upper antennæ seven-jointed, and beset with numerous long plumose setæ, which are mostly distributed as follows,—four from the apices of the fourth, fifth, and sixth joints, and three from the apex of the terminal or seventh joint. Lower antennæ five-jointed, bearing a fascicle of five or six setæ of variable length, and on the inner side of the third joint a short bi-articulate seta; terminating in four long curved and serrated claws; a few short setæ also arise from the sides of the fourth joint, near the middle; second pair of jaws smaller than the first, in the male prehensile, and in the female consisting of a short, simple, setiferous lobe, a subconical, simple, or obscurely articulate palp, which projects backward, and terminates in three long setæ, and a small branchial plate, bearing six radiating respiratory setæ. Postabdominal rami long and slender, bearing at the apex two long and unequal curved claws, and a short seta; a short seta springs also from the inner margin of the ramus at or below the middle. The males furnished (mostly, if not always) with two mucous glands, consisting of a cylindrical axis, on which are set seven whorls of radiating filaments, the whole connected with an efferent tube or “vas deferens.”

1. CYPRIS COMPRESSA, *Baird*. Plate I, figs. 5, 6.

1835. CYPRIS COMPRESSA, *Baird*. Trans. Berw. Nat. Club, vol. i, p. 100, t. iii, fig. 16; (1850) Brit. Entom., p. 154, t. xix, figs. 14, 14 a—c.
1853. — — *Lilljeborg*. De Crust. ex. ord. trib., p. 112, t. x, figs. 16—18.
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1854. — (CYPRIA) FUNCTATA, *Zenker*. Anatomisch-system. Stud. über die Krebsthiere, p. 77, taf. 3 A.

Shell much compressed, seen from the side broadly reniform, greatest height situated in the middle, and equal to more than two thirds of the length; extremities broadly



rounded, superior margin excessively and evenly arched, inferior rather deeply sinuated in the middle; seen from above compressed, ovate, pointed in front, rounded off behind, greatest width situated near the middle and equal to a little more than one third of the length. Surface of the shell smooth and polished (recent specimens all usually more or less marked with distant but rather large circular impressions); colour yellowish-brown, sometimes with pellucid colourless patches.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Switzerland, Germany, Bohemia, Tyrol.

*Fossil*.—Hornsea and Branston Fen, England; Dipple, Scotland.

## 2. CYPRIS SALINA, *Brady*. Plate I, figs. 17—19.

1850. CYPRIS STRIGATA, *Baird*. Brit. Entom., p. 157.

1868. — SALINA, *Brady*. Monog. Recent Brit. Ostr., p. 368, pl. xxvi, figs. 8—13.

Shell, as seen from the side, broadly reniform, greatest height situated in the middle and equal to nearly two thirds of the length, extremities equally and broadly rounded, superior margin boldly and evenly arched, inferior rather deeply incurved; outline, as seen from above, narrowly ovate, anterior extremity much attenuated and bluntly mucronate, posterior subacuminate, greatest width considerably less than half the length, situated in the middle. Hinge- and contact-margins of the valves very flexuous, the latter thickened and prominent. Surface of the shell smooth or very slightly pubescent. Recent specimens beautifully marked with brown striæ and blotches.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain.

*Fossil*.—Crofthead, Scotland.

It may perhaps be doubtful whether the specimen here described is properly referable to *C. salina*, as it differs from the recent specimens of that species not only in being considerably smaller but also to some extent in lateral outline which is more nearly reniform. The smaller size may depend upon immaturity, and the differences of shape are not sufficient to warrant its separation as a distinct species; the absence of colouring cannot be considered important in a fossil example, and, indeed, sometimes occurs in recent specimens.

## 3. CYPRIS VIRENS (*Jurine*). Plate II, figs. 27, 28.

1820. MONOCULUS VIRENS, *Jurine*. Hist. des Monocles, p. 174, pl. xviii, figs. 15, 16.

1850. CYPRIS TRISTRIATA, *Baird*. Brit. Entom., p. 152, t. xviii, figs. 1, 1 a—i, 2, 3.

1853. CYPRIS VIRENS, *Lilljeborg*. De Crustaceis ex ord. trib., p. 117.

1868. — — *Brady*. Monog. Recent Brit. Ostrac., p. 364, pl. xxiii, figs. 23—32, and pl. xxxvi, fig. 1.

Carapace, as seen from the side, oblong, reniform; extremities rounded and nearly equal, superior margin evenly arched, highest in the middle, height equal to more than half the length; inferior gently sinuated, seen from above oblong, ovate, pointed in front, narrowly rounded behind; greatest width situated in the middle, and equal to about half the length. Shell thin, slightly punctate or perfectly smooth; in recent specimens greenish and slightly pubescent.

Length,  $\frac{1}{4}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Sweden, Switzerland, Bohemia.

*Fossil*.—Crofthead, Scotland.

Though a common species in most parts of Great Britain at the present time, we have met with very scanty traces of *C. virens* in the fossil condition; indeed, for this reason we have been compelled to give figures and description from recent specimens, our fossil examples consisting of mere fragments, which, however, we can scarcely doubt are rightly referred as above. It is remarkable that a species so abundant in the recent state should be so poorly represented in the later lacustrine and fluvial deposits; perhaps an explanation may be found in the fact that *C. virens* chiefly haunts small grassy pools and ditches, and, so far as our experience goes, is pretty much absent (except at the grassy margins) from those larger expanses of water whose deposits are most likely to come under the observation of the palæontologist. These remarks apply equally to some other species, *e.g.* *C. reptans* and *Candona candida*.

#### 4. CYPRIS OVUM (*Jurine*). Plate I, figs. 29—31.

1820. MONOCULUS OVUM, *Jurine*. Histoire des Monocles, p. 179, pl. xix, figs. 18, 19.

1850. CYPRIS MINUTA, *Baird*. Brit. Entom., p. 155, tab. xviii, figs. 7, 8.

1868. — OVUM, *Brady*. Monog. Recent Brit. Ostr., p. 373, pl. xxiv, figs. 31—34, 43—45, and pl. xxxvi, fig. 8.

Carapace, as seen from the side, subovate, highest in the middle, height equal to two thirds of the length; extremities well rounded, the anterior much the wider, superior margin very boldly arched, sloping more steeply behind than in front, inferior almost straight; seen from above ovate, tapered and acuminate in front, broadly rounded behind, greatest width situated near the middle, and slightly exceeding half the length. Surface smooth, closely set with minute round punctations. Colour light brown.

Length,  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Switzerland.

*Fossil*.—Whittlesea; Cardiff.

5. *CYPRIS LÆVIS*, Müller. Plate I, figs. 25—28.

1785. *CYPRIS LÆVIS*, Müller. Entomotraca, p. 52, tab. iii, figs. 7—9.  
 1851. — ? *PANTHERINA*, Fischer. Ueber das genus *Cypris*, p. 163, tab. xi, figs. 6—8.  
 1853. — OVUM, Lilljeborg. De Crustaceis, p. 113, tab. x, figs. 13—15.  
 1854. — (*CYPRIS*) —, Zenker. Anat.-syst. Studien, p. 70, tab. 3 B.  
 1856. — OVUM, Jones. Monog. Tert. Entom., p. 14, pl. i, figs. 4 a, 4 b.  
 1868. *CYPRIS LÆVIS*, Brady. Monog. Recent Brit. Ostrac., p. 374, pl. xxiv, figs. 21—26; and pl. xxxvi, fig. 5.

Shell very tumid; seen from the side forming almost three fourths of a circle, extremities broadly rounded, superior margin excessively arched, regularly curved behind, but somewhat flattened in front of the middle; inferior convex towards the extremities, straight in the middle; seen from above, ovate, widest in the middle, greatest width nearly equalling the height, anterior extremity acuminate, posterior broadly rounded. Surface of the shell perfectly smooth and polished; colour chestnut brown.

Length,  $\frac{1}{10}$ th of an inch.

We were at one time disposed to regard this as a new and distinct form; but, after examining specimens of *C. lævis* from many widely separated localities, it seems to be so variable in respect of size, outline, and colouring, that we can scarcely avoid the conclusion that our Whittlesea specimens belong to the same category. The form figured in the 'Monograph of Recent British Ostracoda,' though apparently common in the county of Durham in a living state, is, perhaps, more pronounced as to the tumidity of the posterior and tapering of the anterior extremity than is usual with the species.

DISTRIBUTION. *Recent*.—Great Britain, Denmark, Germany.

*Fossil*.—Cambridgeshire, Whittlesea, England; Dipple, Scotland.

6. *CYPRIS CINEREA*, Brady. Plate II, figs. 6, 7.

1868. *CYPRIS CINEREA*, Brady. Monog. Recent Brit. Ostrac., p. 374, pl. xxiv, figs. 39—42, and pl. xxxvi, fig. 7.

Carapace oval, tumid, higher in front than behind; greatest height equal to nearly two thirds of the length. Anterior margin broad and well rounded, posterior narrowed and rather obliquely rounded. Ventral margin straight or very slightly incurved, dorsal forming a flattened arch, and sloping more steeply behind than in front. Seen from above, rhomboidal or lozenge-shaped, greatest width in the middle, and equal to more than half the length; from the middle the sides taper evenly towards the extremities, the

anterior of which is acutely, the posterior subacutely, pointed. End-view very broadly ovate, pointed above and below. The right valve considerably overlaps the left. Surface of the shell smooth or very finely punctate.

Length of fossil specimens  $\frac{1}{8}$ th, recent  $\frac{1}{3}$ th, of an inch.

DISTRIBUTION. *Recent*.—Yorkshire moors.

*Fossil*.—Crofthead, Scotland.

Some doubt may, perhaps, attach to our identification of these specimens, none of which were quite perfect, and most merely worn and separated valves; but except in size they approach very closely to the form described by one of the present authors under the name *Cypris cinerea*. Our written description is taken from recent specimens, but will be found to agree very closely with the figure taken from a fossil carapace, and given in Plate II of this Memoir.

7. CYPRIS GIBBA, *Ramdohr*. Plate XV, figs. 5, 6.

1808. CYPRIS GIBBA, *Ramdohr*. Magaz. d. Gesellsch. naturforsch. Freunde zu Berlin, ii, p. 91, t. iii, figs. 13—17 (*fide* Jones).  
 1856. — — *Jones*. Mon. Entom. Tertiary Form., p. 15, pl. i, figs. 3 *a—f*, and Woodcut, fig. 1, p. 16.  
 1868. — — *Brady*. Monog. Recent Brit. Ostr., p. 369, pl. xxiv, figs. 47—54, and pl. xxxvi, fig. 2.  
 1850. ? CYTHERINA EXPANSA, *Reuss*. Haidinger's Abhandl., Band iii, p. 60, taf. ix, fig. 11.

Valves, as seen from the side, oblong, subreniform, nearly equal in height throughout, marked usually by two deep transverse furrows extending from the anterior half of the dorsum to near the middle of the valve; sometimes also bearing a prominent tubercle on the posterior portion of the valve; extremities well rounded and nearly equal, the posterior often bordered below the middle with a series of small, sharp, but irregularly placed spines. Superior margin nearly straight, inferior deeply sinuated in the middle; seen from above the shape is oblong-ovate, compressed, width equal to rather more than one third of the length; obtusely pointed in front, rounded off behind, the lateral sulci showing as marginal indentations. Shell thick and strong, closely and rather coarsely punctate, usually whitish or buff coloured.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Germany, Holland.

*Fossil*.—England: Cambridge Fens, Grays, Clacton, Reculvers, Hornsea, Whittlesea, Branston Fen. Scotland: Crofthead, Dipple, Teralley.

8. *CYPRIS REPTANS* (*Baird*). Plate II, figs. 31—32.

1835. *CANDONA REPTANS*, *Baird*. Trans. Berw. Nat. Club, i, p. 99, pl. iii, fig. 11;  
and Brit. Entom., p. 167, pl. xix, figs. 3, 3 a  
(1850).
1856. — — — *Jones*. Monog. Tert. Entom., p. 16, pl. i, figs. 7 a—7 c.
1853. *CYPRIS* — — *Lilljeborg*. De Crustaceis, p. 123, tab. xi, figs. 21—23,  
t. xii, figs. 7—9.
1868. — — — *Brady*. Monog. Recent Brit. Ostr., p. 370, pl. xxv,  
figs. 10—14, and pl. xxxvi, fig. 4.

Valves oblong, subreniform, compressed, unequal, the left being considerably the larger; seen from the side the anterior and posterior extremities are obliquely rounded, somewhat angular below and nearly equal in height, the posterior somewhat the higher; ventral margin slightly sinuated, dorsal straight or very slightly arched; seen from above the carapace is compressed, oblong-ovate, prominently keeled in front and below; surface perfectly smooth, and in recent species variously banded with shades of green, orange, and brown.

Length,  $\frac{1}{11}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain and Ireland, Sweden, Bohemia, Tyrol.

*Fossil*.—England: Berkshire, Cambridgeshire, Essex, Hornsea, and Whittlesea.

Genus 2.—*CYPRIDOPSIS*, *Brady*.

Like *Cypris*, except that the post-abdominal rami are rudimentary, consisting of two slender setiform prolongations thickened below and rising together from a common base. The second feet are terminated by a short hooked claw, and two moderately long setæ.

1. *CYPRIDOPSIS OBESA*, *Brady* and *Robertson*. Plate I, figs. 1—4.

1869. *CYPRIDOPSIS OBESA*, *B. & R.* Ann. and Mag. Nat. Hist., ser. 4, vol. iii,  
pl. xviii, figs. 5—7, and vol. vi, p. 19.

Carapace of the female, as seen from the side, subtriangular or subreniform, highest

in the middle, height equal to nearly two thirds of the length; anterior extremity well rounded, posterior also rounded, but more acutely; superior margin boldly arched, inferior slightly sinuated near the middle. Seen from above, broadly ovate, pointed in front, rounded off behind, greatest width situated in the middle, equal to nearly three fourths of the length or more than the greatest height of the shell. Surface of the valves smooth, closely set with small, round, impressed punctures; ventral surface depressed in the middle. Colour yellowish-brown. Valves subequal, the left rather the larger.

Length,  $\frac{1}{8}$ th of an inch.

We have expressed elsewhere ('Ann. and Mag. Nat. Hist.,' vol. vi, loc. cit.) the opinion that this may possibly be only a variety of the common *C. vidua*. To this opinion we still adhere, though without any greater certainty than previously expressed. In the state here described it is at the least a well-marked variety, which without the intervention of intermediate forms would never be suspected of any close relationship to *C. vidua*.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Holland.

*Fossil*.—England: Hornsea, Branston Fen.

## 2. CYPRIDOPSIS ? NEWTONI, *Brady and Robertson*. Plate II, figs. 20, 21.

1870. CYPRIDOPSIS (?) NEWTONI, *B. & R.* Ann. and Mag. Nat. Hist., ser. iv, vol. iv, p. 14, pl. vii, figs. 14—16.

Carapace, as seen from the side, reniform, greatest height in the middle and equal to a little more than half the length; extremities rounded, the anterior being the broader of the two; superior margin boldly arched, inferior sinuated in the middle. Seen from above, compressed, ovate, acuminate in front, rounded behind; greatest width situated near the middle, much less than the height. Surface of the shell punctate, and (in recent specimens) covered with numerous depressed hairs.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—East Anglian Fen District.

*Fossil*.—England: Whittlesea.

## Genus 3—POTAMOCYPRIS, *Brady*.

Carapace compressed; seen from the side, similar to that of *Cypridopsis*, reniform; shell calcareous and rather thick, valves unequal, the right much the larger and overlapping

on the dorsal and middle of the ventral margin; dorsal margin of the left valve somewhat flattened, that of the right boldly arched, hingement simple. Limbs short and stout, superior antennæ six-jointed, shortly setose, inferior altogether destitute of swimming setæ; first and second feet as in *Cypris*; abdomen rudimentary.

In the living state this genus occurs exclusively in rivers or estuaries within a very short distance of the sea; very occasionally in the sea itself, in which case it has probably been washed down from freshwater.

POTAMOCYPRIS FULVA, *Brady*. Plate I, figs. 20—24.

1868. BAIRDIA FULVA, *Brady*. Monog. Recent Brit. Ostr., p. 474, pl. xxviii, fig. 21.

1869. — — *Brady and Robertson*. Ann. and Mag. Nat. Hist., ser. iv, vol. iii, p. 365, pl. xviii, figs. 1—4.

1870. POTAMOCYPRIS FULVA, *Brady*. Nat. Hist. Trans. Northumberland and Durham, vol. iii, p. 366, pl. xiv, fig. 4.

Carapace, as seen from the side, compressed, angularly reniform, higher in front than behind, greatest height situated in front of the middle and equal to more than half the length; anterior extremity well rounded, posterior narrowed, rounded below and sloping steeply above the middle; superior margin arched, almost gibbous at its highest point, whence it slopes with a gentle curve backwards, and more steeply towards the front; inferior margin distinctly sinuated in the middle. Seen from above, much compressed, ovate, extremities acutely pointed, greatest width situated in the middle, and not much exceeding one third of the length. Valves very unequal, the right being much the larger, and overlapping the left both on the dorsal and ventral margins; the left valve is thus much narrower as well as more angular in outline, having its ventral margin more deeply sinuated, and the supero-posteal angle more distinctly marked. Shell-structure rather thick. Surface more or less densely and minutely punctate. Colour (of fossil specimens) yellowish-brown.

Length,  $\frac{1}{88}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain and Ireland.

*Fossil*.—Scotland: Dalmuir.

#### Genus 4—PARACYPRIS, *G. O. Sars*.

Shell smooth, compact, higher in front than behind. Upper antennæ shortly setiferous; lower strongly clawed, and bearing on the antepenultimate joint a pedicillated

hyaline vesicle. Second pair of jaws provided with a branchial appendage; the palp elongated, conical, and inarticulate. Last pair of feet similar to the first, five-jointed, and terminating in a long curved claw. Post-abdominal rami large, bearing at the extremity two strong curved claws and a short seta, and on the posterior margin two long setæ. One eye.

PARACYPRIS POLITA, *G. O. Sars*. Plate XV, figs. 9, 10.

1865. PARACYPRIS POLITA, *G. O. Sars*. Oversigt af Norges marine Ostrac., p. 12.

1868. — — — *Brady*. Monog. Recent Brit. Ostr., p. 378, pl. xxvii, figs. 1—4, pl. xxxviii, fig. 2.

Carapace, as seen from the side, elongated, siliquose or subtriangular, greatest height at the anterior third and equal to more than one third of the length; anterior extremity evenly rounded, posterior much attenuated; superior margin boldly arched, sloping steeply behind; ventral much sinuated in the middle. Outline, as seen from above, compressed, oval, about four times as long as broad, widest in front of the middle; extremities obtusely pointed. Shell smooth and polished, whitish.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain.

*Fossil*.—Scotland: Raised beach, Oban. Norway: Post-tertiary beds.

#### Genus 5—AGLAIA, *Brady*.

AGLAIA, *Brady*. Les Fonds de la Mer, tome premier, p. 90.

Shell smooth and polished, of about equal height before and behind, compressed, subcylindrical. Superior antennæ seven-jointed, beset with short setæ; inferior robust, and bearing at the apices of the joints several strong curved setæ; furnished also with a very small hyaline vesicle, as in *Pontocypris*, and on the penultimate joint with a lash of very short setæ. Mandibles slender, divided at the extremity into about five blunt teeth, and furnished with a large, narrow, branchial palp. First pair of jaws divided into four digitate segments, and having a distinct branchial appendage; second pair also provided with a branchial lamina and with a simple conical 3-setiferous palp. First pair of feet long, five-jointed, and having a very long terminal claw; second pair different from the first, flexuous, four-jointed, last joint armed with three setæ, of which one is very long



and finely pectinate on the inner margin. Post-abdominal rami moderately robust, bearing two curved terminal claws, one seta on the anterior and two on the posterior margin. Testes disposed round the body of the animal; mucous gland of the male elongated and composed of seven series of verticillate filaments.

*AGLAIA* (♀) *GLACIALIS*, nov. sp. Plate XI, figs. 54—56.

Carapace elongate, reniform, rather lower in front than behind, height scarcely equalling half the length. Extremities rounded, superior margin gently arched, inferior sinuated in the middle. Seen from above, ovate, pointed in front and rounded behind, greatest width somewhat less than the height, and situated near the middle. Surface perfectly smooth.

Length,  $\frac{1}{5}$ th of an inch.

This species was found in Bridlington, Drip Bridge.

Genus 6—*ARGILLÆCIA*, *G. O. Sars*.

Valves smooth, elongated, moderately robust, scarcely higher in front than behind. Superior antennæ very robust, five-jointed, first joint very large and stout, the rest beset on the lower margins with strong spines, and on the upper margins, especially in the male, with long setæ; inferior antennæ short and thick, otherwise like *Pontocypris*; the setæ of the antepenultimate joint in the female short, in the male very long and reaching much beyond the terminal claws. Mandibles almost as in *Pontocypris*, the palp, however, having only a single seta in place of a branchial appendage. Palp of the second pair of jaws indistinctly three-jointed, ending in a single straight claw. First pair of feet strong, terminating in two nearly equal claws, second pair unlike the first and almost like those of *Pontocypris*, last joint very short and bearing about three spines, of which one is very long and curved. Post-abdominal rami short, attenuated towards the apices, and with very small terminal claws. Eye wanting.

*ARGILLÆCIA CYLINDRICA*, *G. O. Sars*. Plate XVI, figs. 29—31.

1865. *ARGILLÆCIA CYLINDRICA*, *Sars*. Oversigt af Norges marine Ostrac., p. 18.

1868. ? *PONTOCYPRIS ANGUSTA*, *Brady*. Monog. Recent Brit. Ostrac., p. 387, pl. xxxiv, figs. 43, 44.

Carapace, as seen from the side, elongated, greatest height situated near the middle and equal to less than half the length, rounded in front; posterior extremity obliquely rounded off above, subangular below; superior margin arcuate, inferior gently sinuated in the middle. Seen from above, ovate, widest in the middle, extremities evenly and rather suddenly tapered, subacuminate, width rather less than the height. Shell surface smooth, without sculpture of any kind.

Length,  $\frac{1}{50}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Norway.

*Fossil*.—Scotland: Duntroon, Cartsdyke, Paisley, Dalmuir, Dumbarton.

*Genus 7—CANDONA, Baird.*

Like *Cypris*, except that the lower antennæ possess no tuft of setæ, and that the second pair of jaws are destitute of a branchial appendage. The shell is usually longer and narrower than that of *Cypris*. The animals of this genus have no swimming power, and are very sluggish in their movements, living mostly at the bottom or burying themselves in the mud.

1. CANDONA ALBICANS, *Brady*. Plate I, figs. 10—13.

1864. CANDONA ALBICANS, *Brady*. Ann. and Mag. Nat. Hist., vol. xiii, p. 61, pl. iv, figs. 6—10; and Trans. Tyneside Nat. F. C., vol. vi, p. 107, pl. iii, figs. 6—10.

1868. — — — Monog. Recent Brit. Ostr., p. 381, pl. xxv, figs. 20—25, and pl. xxxvi, fig. 12.

Shell oblong, subreniform, nearly equal in height throughout, height equalling one half the length; anterior margin well and evenly, posterior less boldly and rather obliquely rounded; superior margin straight, inferior deeply sinuated in the middle. Seen from above, evenly ovate, acuminate in front, narrowly rounded behind, greatest width less than the height, situated in the middle. Surface of the shell closely and rather coarsely punctate; colour whitish, often (in the fossil state) yellow from clay stains.

Length,  $\frac{1}{44}$ th of an inch.

DISTRIBUTION. *Recent*.—England; *Fossil*.—England: Hornsea, Whittlesea.

2. *CANDONA DETECTA* (Müller). Plate I, figs. 7—9.

1785. *CYPRIS DETECTA*. Müller. Entomostraca, p. 49, tab. iii, figs. 1—3.  
 1850. *CANDONA* — Baird. Brit. Entom., p. 161.  
 1868. — — Brady. Monog. Recent Brit. Ostrac., p. 384, pl. xxiv, figs. 35—38, and pl. xxxvii, fig. 2.

Carapace, as seen from the side, elongated, reniform, greatest height situated in the middle, and equal to half the length; extremities nearly equally rounded, the posterior rather narrower and flatter; superior margin evenly arched, inferior sinuated in the middle; seen from above, ovate, widest in the middle, width less than the height, extremities acuminate, the anterior the more acute. Shell surface quite smooth or very faintly punctate. Colour whitish.

Length,  $\frac{1}{40}$ th of an inch.

*C. detecta* approaches very nearly the following species, *C. lactea*, and in some cases is not easily separable from it. It is, however, a smaller species, and more distinctly curved or reniform in outline when viewed laterally.

DISTRIBUTION. *Recent*.—England, Germany.

*Fossil*.—England: Branston Fen.

3. *CANDONA LACTEA*, Baird. Plate I, figs. 14—16.

1850. *CANDONA LACTEA*, Baird. Proc. Zool. Soc. Lond., p. 255, pl. xviii (Annulosa), figs. 25—27.  
 1868. — — Brady. Monog. Recent Brit. Ostrac., p. 382, pl. xxiv, figs. 55—58.

Shell, as seen laterally, subreniform, height equal to half the length and nearly equal throughout; anterior extremity well and evenly, posterior somewhat obliquely rounded; superior margin straight in the middle and sloping towards the extremities, inferior very slightly incurved; seen from above, the outline is regularly ovate, with moderately and nearly equally acuminate extremities, greatest width situated in the middle and scarcely equalling half the length. Surface of the shell smooth, yellowish-white.

Length,  $\frac{1}{83}$ rd of an inch.

DISTRIBUTION. *Recent*.—Holland, Great Britain, Ireland.

*Fossil*.—England: Hornsea, Whittlesea, Branston Fen. South Wales: Cardiff new dock basin. Ireland: Belfast new docks. Scotland: Crofthead.

4. *CANDONA COMPRESSA* (*Koch*). Plate II, figs. 10, 11.

CYPRIS COMPRESSA, *Koch*. Deutschland's Crustaceen, h. 21, pl. xvii (*vide* Lilljeborg).

1853. *CANDONA* — *Lilljeborg*. De Crustaceis ex ord. trib., p. 129, tab. xxvi, figs. 1—3.

1868. — — *Brady*. Monog. Recent Brit. Ostrac., p. 382, pl. xxvi, figs. 22—27.

1856. CYPRIS SETIGERA, *Jones*. Tertiary Entomostraca, p. 12, pl. i, figs. 6a—6d.

Carapace, as seen from the side, compressed, subreniform, higher behind than in front, greatest height equal to more than half the length. Anterior extremity obliquely rounded, sloping steeply above to join the short and straight superior margin; posterior broad and well rounded; inferior margin very slightly sinuated, almost straight; seen from above, compressed, ovate, tapering and pointed in front, rounded behind; greatest width in the middle, and equal to less than half the length. Surface smooth (in recent specimens milk-white and thickly covered with short fine hairs), and mostly marked with a reticulated pattern.

Length,  $\frac{1}{30}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Sweden, Holland.

*Fossil*.—England: Whittlesea (Berkshire and Cambridgeshire, *Prof. T. Rupert Jones*).

5. *CANDONA CANDIDA* (*Müller*). Plate II, figs. 29, 30.

1785. CYPRIS CANDIDA, *Müller*. Entomostraca, p. 62, tab. vi, figs. 7—9.

1820. MONOCULUS CANDIDUS, *Jurine*. Hist. des Monocles, p. 176, pl. xix, figs. 7, 8.

1850. *CANDONA LUCENS*, *Baird*. Brit. Entom., p. 160, tab. xix, fig. 1.

1853. — CANDIDA, *Lilljeborg*. De Crustaceis; *Jones*, Tertiary Entomostraca, p. 19, pl. i, figs. 8a—8f, 5a, 5b; *Brady*, Monog. Recent Brit. Ostr., p. 383, pl. xxv, figs. 1—9, pl. xxxvi, fig. 13, and pl. xxxvii, fig. 1.

Carapace, as seen from the side, oblong, lower in front than behind, reniform in the male, subtriangular in the female, greatest height equal to more than half the length. Anterior extremity rounded and rather narrow; posterior obliquely rounded, and produced below into a more or less prominent angle; superior margin highest behind the middle, thence sloping with a flattened arcuate sweep to the front; inferior slightly sinuated in the young and in adult female specimens, but in old examples and in the adult male deeply sinuated in front and prominently convex behind; seen from above, oblong ovate, pointed in front and rounded behind, widest in the middle, greatest width equal to half

the length. Lucid spots about six; usually arranged in two transverse lines, but sometimes (more especially in the variety *tumida* found by us living abundantly in the East Anglian Fen District) arranged in the rosette form shown in Plate II, fig. 29, of this Monograph. Such specimens often exhibit also a reticulated ornamentation on the posterior portion of the shell, which is otherwise perfectly smooth and polished.

Length,  $\frac{1}{8}$ th— $\frac{1}{4}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Holland, Sweden, Switzerland, France, Bohemia, Tyrol.

*Fossil*.—England: Hornsea, Whittlesea, Branston Fen (Forfarshire, Berkshire, Cambridgeshire, Essex; Pleistocene, Essex, *Prof. T. Rupert Jones*).

Genus 8—PONTOCYPRIS, *G. O. Sars*.

Shell thin and fragile, higher in front than behind, elongated, usually subreniform or subtriangular. Antepenultimate joint of the lower antennæ bearing a brush of about five setæ, the longest of which do not much overreach the apices of the terminal claws; at the base of the joint is attached a pedicillated vesicle. Second pair of jaws destitute of a branchial appendage, palp large and subpediform, three-jointed; last joint in the female armed with two long, slightly curved claws. Second pair of feet flexuous, four-jointed; last joint short and armed at the extremity with several short setæ, one of which is conspicuously pectinated. Post-abdominal rami well developed, bearing at the apex two curved claws and a slender seta, on the inner margin three long setæ.

1. PONTOCYPRIS MYTILOIDES (*Norman*). Plate XV, figs. 7, 8.

1862. CYTHERE MYTILOIDES, *Norman*. Ann. and Mag. N. H., vol. ix, p. 50, pl. iii, figs. 1—3.  
 1865. — AVENA, *Norman*. Nat. Hist. Trans., Northumberland and Durham, vol. i, p. 17.  
 1863. CYPRIS SERREULATA, *G. O. Sars*. Zoologisk Reise i Sommeren, 1862, p. 58.  
 1865. PONTOCYPRIS SERREULATA, *G. O. Sars*. Oversigt af Norges marine Ostracoder, p. 15.  
 — — HISPIDA, *G. O. Sars*. Loc. cit., p. 16.  
 1868. — MYTILOIDES, *Brady*. Monograph of the Recent British Ostracoda, p. 385, pl. xxv, figs. 26—30; pl. xxxvii, fig. 4; and pl. xxxviii, fig. 1.  
 1858? BAIRDIA DACTYLUS and var. PUNCTATA, *Egger*. Die Ostracoden der Miocän-Schichten bei Ortenburg, p. 7, taf. i, figs. 3, 4.

Carapace, as seen from the side, elongated, triangular, high in front, tapering to a

point behind ; greatest height situated in front of the middle and equal to somewhat more than one third of the length. Anterior extremity broad and well rounded, posterior obtusely pointed : superior margin obsoletely angular at its highest point, thence sloping steeply with a gentle curve backwards ; inferior distinctly sinuated in the middle. Seen from above, lanceolate with acuminate extremities ; greatest width at the anterior third, scarcely equal to one third of the length. Shell surface granular or finely punctate, thickly set with short appressed hairs, colour brownish. Right valve armed at the infero-posteal angle with eight or ten short marginal teeth.

Length,  $\frac{1}{80}$ th of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland.

*Fossil*.—Scotland : Dumbarton, Cartsdyke, Paisley, Dipple. Norway. Germany ?

## 2. PONTOCYPRIS TRIGONELLA, *G. O. Sars*. Plate XVI, figs. 26—28.

1865. PONTOCYPRIS TRIGONELLA, *Sars*. Oversigt af Norges marine Ostracoder., p. 16.

1868. — — — *Brady*. Monog. Recent British Ostracoda, p. 387,  
pl. xxv, figs. 31—34, and pl. xxxviii,  
fig. 3.

Carapace, as seen from the side, subtriangular ; greatest height situated near the middle and equal to half the length : anterior extremity well rounded, posterior narrower but rounded, superior margin boldly arched, inferior very slightly sinuated in the middle. Seen from above, elongate-ovate, widest a little in front of the middle ; width equal to more than one third of the length, acuminate in front, rounded off behind. Surface of the shell smooth or sparingly punctate.

Length,  $\frac{1}{88}$ th of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Mediterranean, Cape Verd.

*Fossil*.—Scotland : Loch Gilp, Paisley, Cartsdyke, Dipple.

## 3. PONTOCYPRIS ACUPUNCTATA, *Brady*. Plate II, figs. 18, 19.

1866. PONTOCYPRIS ACUPUNCTATA, *Brady*. Brit. Assoc. Report, p. 209 ; Monog.  
Recent Brit. Ostr., p. 386, pl. xxv,  
figs. 53—56.

Lateral view narrowly subreniform or subtriangular, highest in the middle, height equal to half the length. Anterior extremity rounded, posterior obtusely pointed.

Superior margin boldly arched, deeply sinuated in front of the middle. Seen from above, compressed, oval, pointed in front and rounded off behind; greatest width situated about the middle and equal to one third of the length. The surface of the shell in recent specimens appears to be very finely punctate, but a high microscopic power shows each of these markings to be an exceedingly short hair.

Length,  $\frac{1}{40}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland.

*Fossil*.—Scotland: Raised beach, Oban.

Genus 9.—BAIRDIA, *M'Coy*.

Valves unequal in size, the left being considerably the larger, and overlapping the right, both on the dorsal and ventral surfaces. Surface of the shell smooth or nearly so. Carapace, as seen from the side, mostly subrhomboidal or subtriangular. Eyes wanting. Antennæ robust: the upper 6-jointed, first two joints large and thick, the following joints very short and firmly united, but forming with the second joint a very mobile hinge; armed with numerous long setæ. Lower antennæ strong, 5-jointed, second joint bearing on its base a bisetose tubercle, fourth joint elongated, last very short, armed with two long and strong claws. Mandibles large, lower extremity slightly dilated, and armed with six or seven long and strongly serrulated teeth; palp strong, 4-jointed, bearing a very small trisetose branchial appendage. One pair of jaws only, terminating in three narrow subequal branches, and having a well developed branchial appendage which is separated into two parts by a distinct constriction, the basal portion beset below with several long slender setæ, the terminal portion dilated, subovate, and fringed with large ciliated setæ. Three pairs of feet, all of similar structure, directed forwards and protruding from the shell, 4-jointed, and terminating in a long claw; the first pair having attached to its basal joint a large ovate branchial lamina which is fringed with long ciliated setæ. Post-abdominal rami short but well developed, linear, bearing two elongated claws, and a few setæ of unequal length. The animal crawls slowly about amongst the mud.

The foregoing anatomical details are taken from G. O. Sars' recently published account<sup>1</sup> of the genus, based on an examination of *B. complanata*, Brady.

<sup>1</sup> Undersøgelser over Hardangerfjordens Fauna. 1. Crustacea af G. O. Sars (Reiseberetning), 1871.

1. BAIRDIA INFLATA (*Norman*). Plate XV, figs. 1—4.1857. BAIRDIA SUBDELTOIDEA, *A. White*. Pop. Hist. Brit. Crust., p. 293.1849. — — *Narrow* var. *Jones*. Entom. Cretaceous Formation of  
England, p. 23; and (1856)  
Tertiary Entom., p. 52.<sup>1</sup>1862. CYTHERE INFLATA, *Norman*. Ann. and Mag. Nat. Hist., vol. ix, p. 49, pl. iii,  
figs. 6—8.— SUBDELTOIDEA. Brit. Mus. Cat. Brit. Crust., p. 108 (*vide* *Norman*).1868. BAIRDIA INFLATA, *Brady*. Monog. Recent Brit. Ostrac., p. 388, pl. xxvii,  
figs. 9—17, and pl. xxxviii, fig. 5.

Shell tumid; seen laterally, subrhomboidal in outline, highest in the middle; height equal to half the length. Anterior extremity obliquely rounded, flattened or somewhat sinuous, bordered occasionally with a flattened spinous lamina; posterior narrow, rounded, or almost angular, often more or less dentate or spinous; superior margin forming a flattened arch; inferior straight or slightly waved, bulging more or less at its junction with the anterior margin. Seen from above, ovate, widest in the middle, width nearly equal to the height; extremities obtusely pointed; line of junction of the valves waved; on the ventral surface the left valve much overlapping the right. Surface smooth and polished or finely punctate. Muscle-spots arranged in a rosette near the centre of the valve.

Length,  $\frac{1}{3}$ rd of an inch.

Recent examples of this fine species exhibit considerable variety of form and, more especially, of surface-sculpture and spinous armature, some being almost perfectly smooth at the extremities, and others strongly margined with spines or dentate lamellæ; some specimens, again, are clothed towards the extremities with numerous long, stiff bristles. Our fossil examples are, however, as yet so few that these variations have not been noticed, but should the species be found to occur in widely distant beds, we may then expect to find varieties of the kind here described.

DISTRIBUTION. *Recent*.—Great Britain.

*Fossil*.—Scotland: Raised beach, Oban.

2. BAIRDIA (?) CAMBRICA, *nov. sp.* Plate XIII, figs. 20, 21.

Right valve, as seen from the side, rhomboidal in outline, greatest width situated in the middle and equal to more than half the length; anterior extremity gently curved in

<sup>1</sup> These references apply to Prof. Rupert Jones's memoranda on the *recent* shell only; not at all to his figures or description of the fossil form, which is quite distinct from the present species.



an oblique direction, looking downwards and forwards; posterior rounded and narrow, terminating in a strong sharp spine; superior margin boldly arched, gibbous in the middle, sloping steeply behind; inferior almost straight. Seen from above, ovate, tumid. Surface of the shell smooth, sparingly and minutely papillose: lucid spots about four in number, large, and disposed obliquely, as is usual in the Cypridæ.

Length,  $\frac{1}{5}$ th of an inch.

One valve only of this species which appears, however, to be undoubtedly distinct, occurred in the deposit met with on the site of the New Docks Basin at Cardiff.

### *Family 2.—DARWINELLADÆ.*

*Genus—DARWINELLA, Brady and Robertson.*

POLYCHELES, B. & R. Ann. and Mag. N. H., 1870, vol. vi, p. 25.

DARWINELLA, B. & R. Ib., ser. iv, vol. ix, p. 50.

Shell fragile, structureless. Carapace oblong, higher behind than in front; lucid spots ten to twelve in number, linear oblong or wedge-shaped, arranged in a subradiate manner in front of the centre of the valve. Seen from the side, compressed, oblong, subovate; from above, ovate, acuminate in front, obtusely rounded behind. Valves unequal, the right much larger than the left. Antennæ very short and stout, strongly armed with curved claws and bristles. Superior antennæ six-jointed, having all the joints as broad as or broader than long, and beset with stout curved setæ; inferior four-jointed, of nearly equal thickness to the apex, which is armed with four or five strong, slightly curved claws, entirely destitute of poison-gland or urticating setæ, the place of which is occupied by a simple curved seta of moderate length. Mandible broad; truncate at the distal extremity which is provided with six or seven small and slender spiniform teeth; palp three-jointed, its basal joint very wide and fringed with a series of nine very long, curved setæ; second joint long, slender, nearly four times as long as broad, slightly curved and dilated at the distal extremity, where it bears one long and two small setæ; terminal joint more slender, about two thirds of the length of the foregoing and bearing at the truncate apex about six slender curved spines; basal joint of the palp has attached to its upper margin a small crescentic lamina which is fringed with ten branchial filaments. First jaw divided into four short setiferous segments, and bearing a very large oblong palp which is fringed above with about twenty-four long branchial filaments, and has also four deflexed setæ at its base. Second jaw simple, short and wide, truncate at the apex

and divided into several slender, curved spines; bearing a large, three-jointed, pediform palp, and an ovate branchial appendage of moderate size. Two pairs of feet of moderate length, five-jointed, the second pair being much the longest, and having the last joint armed with one long and two small curved setæ; first three joints of nearly equal length, fourth and fifth respectively about one half and one third as long as the preceding. Abdomen ending in a short conical process. Copulative organs of the male of complex structure, the basal portion, on each side, consisting of a subrhomboidal acuminate lamina, the apical portion of an irregularly shaped plate produced laterally into an alæform process, and on the distal margin into a short, strong hook. Female probably viviparous.

DARWINELLA STEVENSONI, *Brady and Robertson*. Plate II, figs. 13—17.

1870. POLYCHELES STEVENSONI, *B. & R.* Ann. N. H., 1870, vol. vi., p. 25, plate vii, figs. 1—7, and pl. x, figs. 4—14.

1872. DARWINELLA — *B. & R.* Ib., vol. ix, p. 50.

Carapace of the *female* as seen from the side, oblong, depressed in front, height equal to more than one third of the length; extremities obliquely rounded, anterior narrowed, posterior broad and obtuse; superior margin nearly straight, curving downwards in front of the middle; inferior slightly sinuated in the middle. Seen from above, ovate, acuminate, widest near the posterior extremity; greatest width about equal to the height; posterior margin indented in the middle at the junction of the two valves; end view nearly circular. Shell of the *male* somewhat more compressed when seen from above and having the greatest width near the middle. The right valve much overlaps the left, especially in the middle of the ventral margin.

Length,  $\frac{1}{3}$ rd of an inch.

DISTRIBUTION. *Recent*.—England, Ireland, and Holland.

*Fossil*.—England: Whittlesea.

### *Family 3.*—CYTHERIDÆ.

#### *Genus 1.*—CYTHERE, *Müller*.

Valves unequal, mostly oblong-ovate, subreniform or subquadrangular; surface variously ornamented,—smooth, punctate, foveolate, strongly rugose, spinous, or tuber-

culated; usually bearing a distinct, polished, and shining tubercle over the anterior hinge-joint. Hingement formed on the right valve by two terminal teeth, on the left by one anterior tooth and a posterior fossa, between which there is frequently a more or less strongly developed bar which is received into a corresponding furrow of the opposite valve; the teeth are in some few cases crenulated, and that of the left valve is often absent. Antennæ robust; superior 5—6-jointed, armed on the anterior margin with three long curved spines, mostly one on the third and two on the fourth joint; inferior 4-jointed, the last joint short and stout, mandibular palp 3—4-jointed, bearing in place of a branchial appendage, a tuft of two to five setæ. Eyes one or two. Structure of the shell usually very dense.

The reasons which induce us to unite the two genera *Cythere* and *Cythereis* have been explained by Mr. Brady in his 'Monograph of the Recent British Ostracoda;' but as they relate entirely to the anatomy of the animal, we do not think it needful to recount them here. It must be abundantly evident to all students of the group that no permanent distinctive character can be found in the *shells* of the two genera.

1. *CYHERE PELLUCIDA*, *Baird*. Plate III, figs. 20—24.

- |       |                           |                |   |
|-------|---------------------------|----------------|---|
| 1850. | <i>CYHERE PELLUCIDA</i> , | <i>Baird</i> . | Brit. Entom., p. 173, pl. xxi, fig. 7.  |
| 1865. | —                         | —              | <i>G. O. Sars</i> . Oversigt af Norges marine Ostracoder, p. 31.                                    |
| 1868. | —                         | —              | <i>Brady</i> . Monograph of recent British Ostracoda, p. 397.<br>pl. xxviii, figs. 22—26, 28.       |
| 1869. | —                         | —              | <i>Brady &amp; Robertson</i> . Ann. and Mag. Nat. Hist., vol. iii,<br>ser. 4, pl. xix, figs. 10—12. |

Carapace of the *female*, as seen from the side, narrow, elongated, almost equal in height throughout, greatest height much less than half the length. Anterior extremity rounded, posterior obliquely subtruncate, angular above at its junction with the dorsal margin; superior margin straight or very slightly convex; inferior sinuated in the middle, gently convex behind. Outline, as seen from above, oblong, ovate, rounded behind, obtusely pointed in front, sides nearly parallel, greatest width situated in the middle and equal to rather more than one third of the length. End-view nearly circular. The male is narrower and more elongated. Hinge-processes distinctly developed. Surface of the shell marked with more or less closely set circular pits, and with one or more curved transverse furrows.

Length,  $\frac{1}{40}$ th of an inch.

The sculpture of the shell is, in this species, subject to much variation as to the closeness and size of the impressions, but this appears to depend largely upon the age and habitat of the specimens. The range of the species in our seas is very extensive: it

is found in estuarine situations where the water is only slightly salt, as well as in the littoral, laminarian, and coralline zones.

**DISTRIBUTION.** *Recent*.—Norway, Great Britain, Ireland, Holland, Mediterranean, Gulf of St. Lawrence.

*Fossil*.—Common in many of the Scottish beds. Ireland: Woodburn, Belfast New Docks, Raised beach, Portrush. Norway: Post-tertiary beds.

2. *CYTHERE CASTANEA*, *G. O. Sars*. Plate XIII, figs. 8—11, and Plate III, fig. 25.

1865. *CYTHERE CASTANEA*, *G. O. Sars*. Oversigt af Norges marine Ostracoder, p. 32.  
 1868. — — *Brady*. Monog. Rec. Brit. Ostr., p. 398, pl. xxviii, fig. 27, and pl. xxxviii, fig. 6.  
 1869. — — *B. & R.* Ann. and Mag. Nat. Hist., ser. 4, vol. iii, pl. xix, figs. 15—18.

Carapace of the *female*, as seen from the side, oblong, subquadrangular, rather higher in front than behind; height equal to half the length; anterior extremity obliquely rounded; posterior rectangularly subtruncate; superior margin sinuous, sloping gently backwards from the anterior third where it is highest, and terminating behind in an obtuse angle; inferior sinuated in the middle and upcurved towards the extremity. Seen from above, ovate, acuminate in front, rounded behind, sides subparallel and more or less distinctly constricted in front of the middle. The shell of the *male* is more compressed and when seen laterally is much more tapered behind, the supero-posteal angle more pronounced, the infero-posteal entirely rounded off; superior margin quite straight and sloping rather steeply backwards. Shell-surface closely set with small rounded pittings, and marked usually with two curved transverse furrows; colour reddish brown.

Length,  $\frac{1}{4}$  and of an inch.

**DISTRIBUTION.** *Recent*.—Great Britain, Ireland, Norway, Holland.

*Fossil*.—Scotland: Tangyburn, Duntroon, Kilchattan, Dipple, Cumbræ, Dumbarton, Paisley, Dalmuir, Oldmains, Govan, West Tarbert, Oban. South Wales: Cardiff New Dock Basin.

Very closely allied to this species are *C. pellucida*, *porcellanea*, *Macallana*, and *tenera*. From the first named *C. castanea* may be distinguished by its usually darker colour, its more closely punctate shell, the pittings of which are always small and round (not oblong or of any considerable size), by the almost cuneate form of the male, and its perfectly straight dorsal margin. *C. tenera* is smaller, has no transverse furrow, is more finely, or not at all, punctured, and is also sparingly papillose. *C. porcellanea* is more flexuous or reniform in outline, smooth or indistinctly sculptured; regularly ovate when seen from above, and has a much less pronounced supero-posteal angle. The same remarks apply to *C. Macal-*

*lana*, which differs from *porcellanea* chiefly in its straighter and more attenuated outline and more rugose sculpture.

3. CYTHERE MACALLANA, *Brady and Robertson*. Plate XIII, figs. 1, 2.

1869. CYTHERE MACALLANA, *B. & R.* Ann. and Mag. Nat. Hist., ser. 4, vol. iii, p. 368, pl. xix, figs. 5—9.

1869. — PROPINQUA, *G. O. Sars.* Undersøgelser over Christianiafjordens Dybvandsfauna, p. 57, and note, p. 58.

Carapace of the *female*, seen from the side, subreniform; greatest height situated in front of the middle, and equal to half the length; anterior extremity evenly, posterior obliquely rounded; superior margin well arched, highest over the eyes, in front of which it is slightly excavated, ending posteriorly in an obtuse angle; inferior sinuated in the middle. Seen from above, ovate, widest in the middle, rounded behind, subacuminate in front; width less than the height. Surface of the shell vaguely and distantly punctate, the ventral surface more or less marked with sinuous grooves. Colour yellowish-brown. The shell of the *male* is longer and narrower, more tapering (as seen laterally) towards the posterior extremity, and has the dorsal margin almost straight; seen from above, the sides are subparallel, and the posterior extremity obtuse; the shell-surface is usually less sparingly punctate than in the female.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland.

*Fossil*.—Scotland: Kilchattan, Cumbræ.

4. CYTHERE PORCELLANEA, *Brady*. Plate XIII, figs. 3—5.

1869. CYTHERE PORCELLANEA, *Brady*. Ann. and Mag. Nat. Hist., ser. 4, vol. iii, p. 47, pl. vii, figs. 1—4.

1869. — . — *B. & R.* Ibid., ser. 4, vol. iii, p. 367, pl. xix, figs. 1—4.

Carapace of the *female*, as seen from the side, reniform; greatest height situated in the middle and equal to half the length; anterior extremity rounded, posterior rotundotruncate, obscurely angulated above; superior margin arched, sloping almost in a right line behind the middle; inferior deeply sinuated in the middle. Seen from above, ovate, widest in the middle, width considerably less than the height; acuminate in front, subacuminate behind: surface of the shell polished, quite smooth, or more or less marked

with vaguely defined rounded impressions which, towards the extremities, sometimes tend to form elongated furrows or undulations. The shell of the *male* is narrower, less deeply sinuated below and more upturned at the posterior extremity.

Length  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Holland.

*Fossil*.—Scotland: Kilchattan, Cumbrae, Cartsdyke, Dalmuir, West Tarbert. South Wales: Cardiff New Dock basin.

5. CYTHERE TENERA, *Brady*. Plate XIII, figs. 6, 7.

1868. CYTHERE TENERA, *Brady*. Monog. recent Brit. Ostr., p. 399, pl. xxviii, figs. 29—32.

Carapace, as seen from the side, oblong, subquadrangular, of nearly equal height throughout; height equal to half the length; anterior extremity well rounded, posterior subtruncate, rounded off below, obscurely angulated above; superior margin straight, gently sloping from before backwards; inferior sinuated in the middle. Seen from above, ovate, widest about the middle, width less than the height; shell-surface smooth, very finely punctate, and ornamented also with a few distant small circular papillæ; no transverse sulcus.

Length of the Cardiff specimens  $\frac{1}{10}$ th of an inch. Usual size  $\frac{1}{5}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Shetland, Bay of Biscay, Besika Bay.

*Fossil*.—Scotland: Wick, Dipple, Oban. South Wales: Cardiff New Dock basin.

5. CYTHERE DEFLEXA, *nov. sp.* Plate XIII, figs. 14, 15.

Valves, as seen from the side, reniform: greatest height situated near the middle and equal to scarcely half the length; extremities well rounded; superior margin arched, almost gibbous in the middle; inferior sinuated. Seen from above, regularly ovate. Shell-surface marked with indistinct, subconcentrically arranged pittings.

Length  $\frac{1}{10}$ th of an inch.

The single valve on which this species is founded does not seem fairly referable to any known form, though in general appearance it approaches somewhat *C. cribrosa*, from which it is separated chiefly by its more flexuous outline and more arcuate dorsal margin.

*Fossil*.—Scotland: Jordan Hill.

6. *CYTHERE CRIBROSA*, *nov. sp.* Plate X, figs. 5—7.

Carapace compressed, oblong; seen laterally, rather higher in front than behind; greatest height equal to half the length; anterior extremity evenly, posterior obliquely, rounded and obsoletely angular about the middle; superior margin gently arched, highest in front of the middle, and terminating behind in an obtuse angle; inferior almost straight. Seen from above, compressed, ovate; anterior extremity subacuminate, posterior narrowly rounded, width less than the height; end view subcircular. Surface of the valves covered with rather closely reticulated furrows which assume a concentric arrangement toward the margins.

Length  $\frac{1}{4}$ th of an inch.

This is a very pretty and distinct species, its nearest relative being, perhaps, *C. Robertsoni*, Brady (see 'Ann. and Mag. Nat. Hist.,' July, 1868), from which it differs chiefly in its somewhat greater size and more compressed and elongated, as well as less angular, form.

*Fossil*.—England: Bridlington.

7. *CYTHERE CRISPATA*, *Brady*. Plate X, figs. 52, 53; and Plate XIII, figs. 12, 13.

1865. *CYTHERE CICATRICOSA*, *G. O. Sars*. Oversigt af Norges marine Ostracoder, p. 33.

1868. *CYTHERE BADIA* (in part), *Brady*. Monog. Rec. Brit. Ostrac., p. 399 (not figures). (Not *C. badia* of Norman.)

1868. — — *Brady*. Les Fonds de la Mer, vol. i, p. 89.

1868. *CYTHERE CRISPATA*, *Brady*. Ann. and Mag. Nat. Hist., ser. iv, vol. ii, p. 221, pl. xiv, figs. 14, 15.

1869. — *CICATRICOSA*, *Brady* and *Robertson*. Ann. and Mag. Nat. Hist., ser. 4, vol. iii, p. 369, pl. xix, figs. 13, 14.

Carapace, as seen from the side, subreniform, higher in front than behind; greatest height in front of the middle, equal to more than half the length; anterior extremity rounded, and often slightly crenulated below the middle; posterior truncate, with slightly rounded angles; superior margin gently arched, sloping from before backwards; supero-posteal angle somewhat produced; inferior margin nearly straight; seen from above the outline is compressed, almost clavate, narrowly rounded in front and truncate behind, with nearly parallel sides, which are sharply constricted near the posterior extremity; width considerably less than half the length. Surface of the shell marked

with irregularly waved depressions, the separations between which sometimes rise into well marked ridges.

Length,  $\frac{1}{8}$ nd of an inch.

This species is, in many respects, not unlike *C. badia*, Norman, with which, indeed, it was confounded in the 'Monograph of the Recent British Ostracoda.' It is, however, distinctly truncate behind, and is usually conspicuously sculptured, or even rugose, with the anterior border minutely crenated. *C. badia*, on the contrary, is but vaguely pitted on the surface, and, seen from above, is pretty regularly ovate and not at all truncate. The Mediterranean form described by Mr. Brady (*op. cit.*) under the specific name *crispata*, though much more prominently rugose, seems to be essentially the same as the northern species. The name *cicatricosa* having been previously applied by Reuss to another species of the same genus, must give way to that here adopted.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Norway, Mediterranean, (?) Australia, Hong Kong.

*Fossil*.—Scotland: Cumbrae. Ireland: Portrush. Norway: Post-tertiary beds.

#### 8. CYTHERE VIRIDIS, Müller. Plate III, figs. 26—28.

1785. CYTHERE VIRIDIS, Müller. Entomostraca, p. 64, tab. vii, figs. 1, 2.  
 1865. — — G. O. Sars. Oversigt af Norges marine Ostracoder, p. 30.  
 1868. — — Brady. Monog. Recent Brit. Ostrac., p. 397, pl. xxviii, figs. 40, 41, 57—59, and pl. xxxviii, fig. 8.

Carapace of the *female* as seen from the side subreniform, rather higher in front than behind, greatest height equal to more than half the length. Extremities well rounded; superior margin nearly straight, inferior deeply sinuated in the middle. Outline as seen from above oblong ovate, pointed in front, greatest width situated in the middle, scarcely equal to half the length; end view ovate. Shell of the *male* more elongated. Surface smooth, marked with small distant punctures.

Length  $\frac{1}{8}$ th of an inch.

*C. viridis* is common in the recent state on our coasts, living mostly between tide-marks, but also in moderate depths of water down to 20—30 fathoms.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Holland.

*Fossil*.—In most of the clay beds in the Clyde district, rarer in the east of Scotland; Portrush, Ireland. Norway, Post-tertiary beds.



9. *CYTHERE LUTEA*, Müller. Plate III, figs. 1—6.

1785. *CYTHERE LUTEA*, Müller. Entomostraca, p. 65, tab. vii, figs. 3, 4.  
 1850. — *RENIFORMIS*, Baird. Brit. Entom., p. 169, tab. xx, figs. 5, 5 a—f.  
 1854. — *LUTEA*, Zenker. Ueber die Krebsthiere, p. 83, tab. v, C.  
 1865. — — *G. O. Sars*. Oversigt af Norges marine Ostracoder, p. 28.  
 1865. — *SETOSA*, Brady. On new or imperfectly known Ostracoda (Trans. Zool. Soc. London), p. 372, pl. lviii, figs. 12, 13, 15 a.  
 1868. — *LUTEA*, Brady. Monograph of Recent British Ostracoda, p. 395, pl. xxviii, figs. 47—56; pl. xxxix, fig. 2.

Carapace of the *female*, as seen from the side, reniform, highest in the middle, greatest height equal to much more than half the length; extremities obtusely rounded, dorsal margin well arched, ventral distinctly sinuated in front of the middle. Outline, as seen from above, oblong-ovate, widest behind the middle, greatest width equal to less than half the length, obtusely pointed in front, broader behind, the hinge-line marked by a deep, sharply-cut sulcus. End view ovate, centrally emarginate above, keeled below. Valves dissimilar in shape, the right higher than the left; its extremities more obliquely truncate. Anterior and ventral borders of the carapace compressed and marked with radiating transverse hair-like lines; central portions covered with a calcareous crust which is marked with distant circular pits, and dotted in the interspaces with numerous small punctures. Hinge-teeth feebly developed, crenulated. Shell of the *male* much more elongated and more angular in outline, inferior margin more deeply sinuated, surface usually more or less waved or ribbed in a sub-radiate manner.

Length  $\frac{1}{30}$ th of an inch.

This species is found living abundantly in the seas of Britain and Scandinavia, mostly in the littoral and laminarian zones; it is also one of the most abundant Post-tertiary fossil species. The shell of the female sometimes nearly approaches in appearance the female *C. villosa*, but a close examination especially of the hinge-joints will always remove any doubt respecting it.

**DISTRIBUTION.** *Recent*.—Baffin's Bay, Iceland, Gulf of St. Lawrence, North Sea, Great Britain, Ireland, Baltic, Mediterranean.

*Fossil*.—Common in nearly all the beds of the west of Scotland, but less frequent on the east. Ireland: Belfast New Docks, Portrush. Canada and Norway, Post-tertiary beds.

10. CYTHERE ALBOMACULATA, *Baird*. Plate IX, figs 1—4.1850. CYTHERE ALBOMACULATA, *Baird*. Brit. Entom., p. 169, pl. xx, fig. 7.1868. — — — *Brady*. Monog. Rec. Brit. Ostrac., p. 402, pl. xxviii, figs. 33—39, and pl. xxxix, fig. 3.

Carapace, as seen from the side, subreniform, greatest height in the middle and equal to half the length. Anterior extremity obliquely rounded, posterior rounded, angular in the middle, above which it is often slightly emarginate; superior margin gently and evenly arched, almost straight in the middle; inferior deeply sinuated in front of the middle. Outline, as seen from above, oblong-ovate, widest in the middle, and nearly thrice as long as broad; extremities pointed; surface of the shell smooth, bearing a few short distantly scattered hairs and often some faintly impressed punctæ: the extremities marked with numerous radiating, hair-like lines.

Length  $\frac{1}{8}$ th of an inch.

This is one of the commonest of living British species, occurring abundantly both between tide-marks and in moderate depths of water. It is not recorded by G. O. Sars as a Norwegian species, but we have seen a single specimen dredged off that coast.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Norway, Levant, Cape Verd.

*Fossil*.—Scotland: Cumbræ, West Tarbert, Dipple, Raised beaches, Oban and Cumbræ. Ireland: Belfast New Docks, Portrush.

11. CYTHERE LEIODERMA, *Norman*. Plate IX, figs. 5, 6.1868. CYTHERE LEIODERMA, *Norman*. Last Shetland Dredging Report, p. 291.1870. — — — *Brady*. Ann. and Mag. N. H., 4th ser., vol. vi, p. 451, plate xix, figs. 11—13.

Carapace, as seen from the side, oblong, sub-quadrangular, highest in front of the middle, greatest height equal to nearly half the length. Anterior extremity rounded, posterior obliquely subtruncate, sinuated in the middle; superior margin highest in front of the middle, where it forms an elevated angle from which it slopes gently backwards almost in a straight line; inferior margin almost straight. Seen from above tumid, ovate, slightly narrowed in front; greatest width equal to the height and situated near the middle; extremities broadly and evenly rounded; hinge-margins somewhat depressed; hinge-teeth very strongly developed. Surface smooth, bearing numerous short scattered setæ, and marked on the anterior margin with several radiating lines.

Length,  $\frac{1}{8}$ th of an inch.

We have met with only one fossil valve of this species, but the characters are so well

marked as to leave no doubt of its identity ; we had indeed described it in MS. as a distinct species years before its discovery in the living state by the Rev. A. M. Norman. We have ourselves still more lately seen many recent specimens from the Gulf of St. Lawrence.

DISTRIBUTION. *Recent*.—Shetland, Gulf of St. Lawrence.

*Fossil*.—Bridlington.

12. CYTHERE GIBBOSA, *B. & R.* Plate XVI, figs. 16—18.

1869. CYTHERE GIBBOSA, *Brady and Robertson*. Ann. and Mag. N. H., ser. iv, vol. iii, p. 368, pl. xxi, figs. 1—3.

Carapace oblong, subtriangular or subtrapezoidal, highest in front of the middle, height fully equal to half the length, anterior extremity obliquely, posterior evenly rounded ; superior margin prominent in front of the middle, thence sloping steeply to the front, more gently and almost in a right line backwards, inferior margin straight or gently convex ; seen from above, subovate, widest near, or a little in front of, the middle, width considerably less than the height, extremities acuminate, end view broadly ovate. Shell rather thin and fragile, smooth and shining, slightly punctate and papillose, the ventral surface greatly depressed in the centre, forming a slight longitudinal fossa.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain and Ireland.

*Fossil*.—Portrush, Ireland.

13. CYTHERE CONVEXA, *Baird*. Plate III, figs. 14—17.

1850. CYTHERE CONVEXA, *Baird*. Brit. Entom., p. 174, pl. xxi, fig. 3.

1856. — PUNCTATA, *Jones*. Monog. Tertiary Entom., p. 24, plate ii, figs. *b—d, f—h* (not *a* and *e*).

1868. — CONVEXA, *Brady*. Monog. rec. Brit. Ostrac., p. 401, pl. xxix, figs. 19—27 ; pl. xxxix, fig. 4.

Carapace of the *female*, as seen from the side, almost semicircular, greatest height in the middle and equal to more than half the length. Anterior extremity broadly rounded, posterior produced below into a somewhat angular beak ; superior margin very boldly arched, highest in the middle, inferior gently sinuated in the middle and convex behind. Outline, as seen from above, oblong-ovate ; greatest width in the middle, and equal to less than half the length ; extremities obtusely pointed ; end view broadly ovate, pointed above and below. The two valves are very unequal in size and dissimilar in shape, the left being the larger and overlapping the right considerably, especially on the dorsal

margin. The posterior beak of the right valve is more squamous and often two or three times emarginate. Surface of the shell covered with closely-set circular impressed puncta. The *male* does not differ much in shape from the *female*.

Length,  $\frac{1}{8}$ th of an inch.

*Cythere convexa* is in the living state widely distributed round the British coast, but nowhere occurs very abundantly; it ranges from the littoral zone to depths of about thirty fathoms, but does not appear to have been noticed either in the seas or glacial deposits of Scandinavia.

Some of the forms described and figured by Professor T. Rupert Jones under the name *Cythere punctata* are undoubtedly referable to the present species, but some of the synonyms and references given by that author do not appear to us to be applicable. We are not acquainted with the figures of *C. punctata* given by Roemer, but that of Reuss, if meant for the present species, is certainly very bad, while his *Cypridina punctatella*, which is doubtfully referred by Professor Jones to the young of the present species, evidently belongs to the group assigned in this memoir to the genus *Loxoconcha*. The same may also be said of Bosquet's *Cythere punctatella*. Lastly, it may be noted that G. O. Sars has erroneously applied Dr. Baird's name (*convexa*), having assigned it to a totally different form, the *Cytheropteron latissimum* of this Monograph.

DISTRIBUTION. *Recent*.—Great Britain and Ireland, Levant, Bay of Biscay.

*Fossil*.—Scotland: Raised beaches, Cumbrae and Oban; West Tarbert Silt. Ireland: Portrush; New Docks, Belfast.

#### 14. CYTHERE CICATRICOSA, Reuss. Plate XIV, figs. 7—10.

1849. CYPRIDINA CICATRICOSA, Reuss. Die fossil. Entomostrac. Oesterreich. Tertiärbeckens, p. 27, pl. ix, figs. 21 a, b.

1852. CYTHERE CICATRICOSA, Bosquet. Entom. foss. terr. tertiair. France, p. 76, pl. iii, fig. 13.

1865. — ARBORESCENS, Brady. Ann. Mag. N. H., vol. xvi, pl. ix, figs. 5—8.

Carapace, as seen from the side, subovate, highest in the middle, greatest height equal to two thirds of the length; anterior extremity broadly rounded, posterior slightly produced below the middle; superior margin boldly arched, inferior somewhat convex and slightly sinuated in front of the middle. Seen from above, ovate, tapering evenly to the extremities, which are sharply pointed; greatest width in the middle and equal to half the length. The end view is somewhat pyramidal, being pointed at the top and widest below the middle; the base broad and rounded. Shell-surface marked with closely set rounded or subangular impressions, which on the ventral aspect coalesce so as to form beaded furrows.

Length,  $\frac{1}{8}$ th of an inch.

This species differs from *C. convexa*, Baird (*C. punctata*? Münster) in its greater proportionate height, in being more tumid below the middle, and in being destitute of any very prominent beak at the postero-inferior angle. In lateral outline it approaches closely to a recent Mediterranean species, *C. Speyeri*, Brady,<sup>1</sup> but is smaller and very much less tumid, besides being deficient in the beak, which that species possesses in common with *C. convexa*.

DISTRIBUTION. *Fossil*.—Brick-earth of the Nar; Hopton Cliff, Yarmouth. Tertiary beds of France and Germany.

15. CYTHERE COSTELLATA, Römer. Plate XVI, figs. 13—15.

1838. CYTHERINA COSTELLATA, Römer. Neues Jahrb. Mineral., &c., p. 517, pl. vi, fig. 24 (*vide* Bosquet).

1850. CYTHERE COSTELLATA, Bosquet. Entom. foss. terr. tertiär. France, p. 58, pl. ii, figs. 11 a—d.

1856. — — Jones. Monog. Tert. Entom., p. 32, pl. v, fig. 11.

Carapace, as seen from the side, oblong, somewhat cuneiform, much higher in front than behind, height equal to fully half the length, anterior extremity boldly and obliquely rounded, posterior also rounded, but narrow, and bearing in the middle one moderate-sized spine with two or three smaller ones below; superior margin somewhat angulated in front, behind which it is slightly emarginate and thence slopes backwards almost in a right line, inferior almost straight for the first two thirds of its course, then curved upwards; seen from above, somewhat lozenge-shaped, greatest width situated behind the middle and equal to half the length, obtusely pointed or almost sub-truncate in front, doubly mucronate behind. Shell dense and strong, marked longitudinally with numerous (10—12 on the lateral aspect of each valve) strong, rounded, flexuous ribs; the left valve considerably larger than the right, and overlapping with a broad flange on the ventral surface of the shell; hinge-line on the dorsal aspect depressed so as to form a wide sulcus, and sharply bent in front.

Length  $\frac{1}{40}$ th of an inch.

DISTRIBUTION. *Fossil*.—England: Tertiary beds of Bracklesham, and Pholas-bed of Selsey. Tertiary, France.

Our figures of this species were already lithographed before we became aware that it could not rightly be claimed as belonging to the Post-tertiary Ostracoda. The "Pholas-bed" in which our specimens were found is certainly of considerably earlier date, unless indeed the Ostracoda which it contains have been washed into it from some older deposit.

<sup>1</sup> Described in 'Les Fonds de la Mer,' tom. i, p. 99, pl. xii, figs. 8—10.

16. CYTHERE CLUTHÆ, *nov. sp.* Plate XIII, figs. 16, 17.

Shell, as seen from the side, subquadrate, highest in front, greatest height equal to nearly two thirds of the length; anterior extremity broad and well rounded, posterior narrow and obliquely rounded; superior margin almost straight, sloping from before backwards, inferior deeply sinuated in the middle; seen from above the outline is oblong, subrectangular, with parallel, irregularly sinuous sides, suddenly tapered off towards the front, which is truncated; posterior extremity irregularly rounded. Shell-surface irregularly mamillated, closely set with small subrotund pittings; within the ventral margin runs a broad rounded ridge, while the anterior half of the valve is occupied chiefly by one, the posterior half by two, large rounded tubercles.

Length  $\frac{7}{8}$ th of an inch.

DISTRIBUTION.—*Fossil*.—Scotland: Cumbrae, Cartdyke, Govan, Lag Arran.

17. CYTHERE FINMARCHICA (*G. O. Sars*). Plate X, figs. 18—21.

1865. CYTHEREIS FINMARCHICA, *Sars*. Oversigt. Norges mar. Ostr., p. 41.

1868. CYTHERE — *Brady*. Monog. Rec. Brit. Ostrac., p. 410, pl. xxxi, figs. 9—13.

Carapace of the *female*, as seen from the side, oblong, quadrangular, higher in front than behind, greatest height equal to about half the length; anterior extremity rounded; posterior subtruncate, somewhat angulated in the middle and usually divided into four or five blunt teeth below. Superior margin sloping almost in a straight line from before backwards; inferior gently sinuated in the middle; seen from above ovate, with subparallel sides and obtuse extremities; width scarcely equalling the height. Surface of the shell marked with vaguely defined rounded pittings, and often with a median transverse sulcus, in front of which is a large rounded tubercle bearing numerous (9 to 12) irregularly disposed muscle-spots. Shell of the *male* narrower and more elongated.

Length  $\frac{1}{8}$ th of an inch.

Nearly allied to *Cythere tuberculata*, from which it differs, however, in having the anterior margin entire or at most only slightly crenated, and in the character of the posterior teeth, which are marginal crenulations rather than true spines; the posterior portion of the shell is also much less tumid than in the larger species, and there is only one large central tubercle.

DISTRIBUTION. *Recent*.—Davis's Straits, Norway, Great Britain, Ireland, Bay of Biscay, Cape Verd, St. Vincent.

*Fossil*.—Scotland: Gamrie, Wick, Loch Gilp. Norway: Post-tertiary beds.

18. *CYTHERE CUNEIFORMIS*, *Brady*. Plate X, figs. 23—26.

1865. *CYTHERE VENTRICOSA*, *Sars*. Op. cit., p. 34.

1868. — *CUNEIFORMIS*, *Brady*. Monog. Rec. Brit. Ostrac., p. 404, pl. xxxi, figs. 47—54.

Carapace of the *female* subprismoid, much depressed behind, angular on the dorsal and flattened on the ventral surface; seen from the side, the outline is subcuneiform, anterior extremity broadly rounded, posterior narrowed and produced to an obtusely mucronate point; superior margin sloping steeply and in a straight line from before backwards, inferior almost straight. Seen from above, ovate, extremities sharply mucronate, greatest width about equal to the height; end-view triangular, base and sides convex. Shell-surface marked more or less profusely with rounded depressions and tubercles, transversely sulcate in the middle, and longitudinally furrowed on the ventral surface.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Norway.

*Fossil*.—Scotland: Raised beach, Oban; West Tarbert. Norway.

19. *CYTHERE LIMICOLA* (*Norman*). Plate X, figs. 1—4.

1865. *CYTHEREIS LIMICOLA*, *Norman*. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 20, pl. vi, figs. 1—4.

1865. *CYTHERE NODOSA*, *Sars*. Op. cit., p. 34.

1866. — *COMPLEXA*, *Brady*. Brit. Assoc. Report, p. 210.

1865. — *AREOLATA*, *Brady*. Trans. Zool. Soc., vol. v, p. 381, pl. lxii, figs. 2 a—d.

1868. — *LIMICOLA*, *Brady*. Monog. Rec. Brit. Ostrac., p. 405, pl. xxxi, figs. 38—41, 43—46.

Carapace of the *female*, as seen from the side, subtrapezoidal, not much higher in front than behind, greatest height situated over the anterior hinge and equal to about two thirds of the length; anterior extremity well rounded; posterior subtruncate, obtusely rounded below and slightly excavated above the middle; superior margin

abruptly angular at each extremity, between which it is more or less concave; inferior slightly waved. Seen from above, the outline is broadly hastate or boat-shaped, widest near the posterior extremity, tapering gently and in a curve towards the front, but suddenly and steeply backwards; margins irregularly sinuous; greatest width about equal to the height. End-view subtriangular, base broad and flat, apex obtusely rounded, sides excavated. Shell-surface uneven, rugose, often obscurely reticulated, the interstices being finely punctate; a conspicuous polished and rounded tubercle over the anterior and two near the posterior hinge; a strongly marked longitudinal ridge running along the whole length of the valves just within the ventral margin.

Length,  $\frac{1}{4}$ th of an inch.

DISTRIBUTION. *Recent*.—Baffin's Bay, Norway, Great Britain.

*Fossil*.—Scotland: Duntroon, Kyles of Bute, Kilchattan, Cumbræ, Dumbarton, Cartsdyke, Inch Lonaig, Tangy Burn, Terally. Canada: Post-tertiary beds.

20. CYTHERE GLOBULIFERA, *Brady*. Plate IX, figs. 18—20, and (?) 21, 22; Plate XII, figs. 11, 12; and Plate XV, figs. 19, 20.

1868. CYTHERE GLOBULIFERA, *Brady*. Monog. Rec. Brit. Ostrac., p. 406, pl. xxxi, fig. 42.

Valves, as seen from the side, subcuneiform or subquadrangular, greatest height in front, and equal to nearly two thirds of the length. Anterior extremity broadly and evenly rounded; posterior narrower and obliquely rounded; superior margin perfectly straight and terminating in an obtuse angle at each extremity; inferior straight or very slightly sinuous. Outline, as seen from above, irregularly ovate, sinuous, widest at the posterior third; width equal to half the length; surface delicately reticulated, and towards the anterior and inferior margins concentrically rugose, bearing also, near the superior margin, three large subglobular tubercles, and near the lower margin an elongated alæform projection, which extends over a large portion of the ventral surface.

Length,  $\frac{1}{10}$ th of an inch.

This species was first described by Mr. Brady from a single specimen found in shell-sand by Dr. Alcock at Roundstone. The specimens found by us in the Scotch glacial clays do not materially differ from the Roundstone specimen, and serve to establish the species on a more satisfactory basis than before. It is possible that the difference of outline between figs. 18 and 19 (Plate IX) may be sexual, the former representing the male, the latter the female. The valve represented in figs. 21 and 22 is, perhaps, not



fairly referable to *C. globulifera*; but in the absence of further examples it seems best to place it here provisionally.

DISTRIBUTION. *Recent*.—Ireland, Spitzbergen.

*Fossil*.—Scotland: Paisley, Govan, Barrie, Elie, Dryleys, Annachie, Errol. England: Bridlington. Canada: Post-tertiary beds.

21. *CYTHERE JEFFREYSII*, *Brady*. Plate III, figs. 18, 19.

1868. *CYTHERE JEFFREYSII*, *Brady*. *Monog. Rec. Brit. Ostr.*, p. 412, pl. xxix, figs. 51—55.

Carapace, as seen from the sides, oblong, subcuneiform, highest at the anterior third, greatest height equal to more than half the length. Anterior extremity broad, well rounded, fringed below with several (twelve to sixteen) small teeth, and marked with numerous radiating, hair-like lines; posterior much narrowed; superior margin somewhat angular over the eye, thence sloping steeply and almost in a straight line backwards; inferior slightly sinuated in front, then sloping upwards with a slight convexity. Outline, as seen from above, subhexagonal, sides nearly parallel, extremities tapering abruptly, obtusely pointed; width equal to about half the length. Surface of the shell finely reticulated, the lines of reticulation being made up of moniliform tubercles.

Length,  $\frac{1}{40}$ th of an inch.

*C. Jeffreysii* has been found recent on the western coasts of Ireland and Scotland, and also off the Channel Islands, but in all these localities is very rare. The surface-marking of the shell is such as is found in the young of species which in the adult stage are strongly spinous; and a similarly ornamented form, which proved to be the young of *C. echinata*, Sars, was described by Mr. Brady in the 'Zoological Transactions' under the name of *Cythere calenata*. Sars's description had not, however, been published at that time, nor had Mr. Brady seen the species in its adult state. The valve of *C. Jeffreysii* figured in our plate is, probably, a young one; but some of the recent specimens appear to be fully grown, and still exhibit similar characters. We have, therefore, but little hesitation in considering it a distinct species.

DISTRIBUTION. *Recent*.—Great Britain, Ireland.

*Fossil*.—Raised beach, Oban.

22. *CYTHERE PULCHELLA*, *Brady*. Plate III, figs. 29—37.

1868. *CYTHERE PULCHELLA*, *Brady*. Monog. Rec. Brit. Ostrac., p. 404; Ann. Mag. N. H., ser. iv, vol. ii, p. 32, pl. v, figs. 18—20.

1869. — — *Brady* and *Robertson*. Ann. Mag. N. H., ser. iv, vol. iii, p. 369, pl. xx, figs. 1—3.

Carapace of the *female*, as seen from the side, oblong, subquadrangular, highest at the anterior third, greatest height equal to more than half the length; anterior extremity broad and well rounded; posterior narrower and obliquely subtruncate; superior margin slightly arched, sloping from before backwards; inferior sinuated in front of the middle. Outline, as seen from above, ovate, widest in the middle, greatest width equal to less than half the length, extremities obtusely pointed. End-view broadly ovate. The shell of the *male* (fig. 33) is more elongated and angular in outline. Surface covered with closely set, small, circular impressions, and marked mostly towards the anterior and posterior margins with faintly waved grooves or rugæ. Lucid spots numerous (fig. 36), small, forming an irregular group near the centre of the valves. Hinge-processes of the right valve distinctly crenated (fig. 35).

This species is very similar in shape and general appearance to *C. villosa*, but is smaller, more delicately sculptured, and less angular in outline; the hingement and characters of the lucid spots are also widely different. In the recent state it has been found (but sparingly) in the Arctic seas, the west of Ireland, north-west of Scotland, and Holland.

DISTRIBUTION. *Recent*.—Baffin's Bay, Scotland, Ireland, Holland.

*Fossil*.—Scotland: Duntroon, Loch Gilp, Kilchattan, Dumbarton. Ireland: Woodburn.

23. *CYTHERE VILLOSA* (*G. O. Sars*). Plate III, figs. 7—13.

1865. *CYTHEREIS VILLOSA*, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 42.

1868. *CYTHERE* — *Brady*. Monog. Rec. Brit. Ostrac., p. 411, pl. xxix, figs. 28—32.

Carapace of the *female*, as seen from the side, subreniform, highest in the middle, greatest height equal to more than half the length. Anterior extremity obliquely rounded; posterior obliquely truncate and sinuated; dorsal margin evenly arched, ventral sinuated in front and forming a subangular projection behind the middle. Outline, as seen from

above, oblong-ovate, widest in the middle, width less than the height. Shell of the *male* narrower, more compressed, about twice as long as high; upper margin nearly straight and sloping from before backwards, inferior also nearly straight, the post-median angular prominence more conspicuous than in the female. Hinge-teeth strongly developed; surface of the valves sculptured with deep and large fossæ, which often assume towards the margins a somewhat radiated arrangement (figs. 7 and 12); at other times, probably in old specimens, they become indistinct (fig. 8) and in the centre obsolete.

Length,  $\frac{1}{40}$ th of an inch.

*Cythere villosa* is a common recent species, occurring plentifully on the shores of Britain (except on the east coast, where it is rare) and Norway in the littoral and laminarian zones, but not often extending into great depths; it is also one of the commonest of the Glacial Ostracoda.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Norway, Bay of Biscay, Davis's Straits, Gulf of St. Lawrence.

*Fossil*.—Common in nearly all the Scottish Post-tertiary beds. England: Hopton Cliff, Whittlesea. Ireland: Belfast New Docks, Portrush. Norway.

24. CYTHERE LATICARINA, *Brady*. Plate IX, figs. 23—26.

1868. CYTHERE LATICARINA, *Brady*. Monog. Rec. Brit. Ostrac., p. 412, pl. xxxi, figs. 1—4.

Carapace of the *female* (?), as seen from the side, subquadrate, highest in front, greatest height equal to more than half the length. Anterior extremity broadly rounded, fringed below with numerous (about sixteen) very fine teeth; posterior rounded, narrow, emarginate above the middle; superior margin prominently angular over the anterior hinge, from which it slopes backwards in a slightly jagged line; inferior sinuated in the middle. Outline, as seen from above, subhexagonal, with parallel sides and very blunt, equally tapered extremities; greatest width in the middle and equal to about half the length. The surface of the shell is uniformly sculptured with rather large subquadrate pittings, and the eye-tubercles are large and exceedingly prominent; the margins of the valves very broad and thick, forming a wide encircling fillet or keel.

Length,  $\frac{1}{3}$ rd of an inch.

This is very distinct from all other species, except perhaps *C. marginata*, Norman, of which one specimen only is extant, and which must be looked upon as a somewhat doubtful form. Though bearing some resemblance to *C. tuberculata*, *C. laticarina* is easily distinguished from that species by the different proportions, and even contour of the carapace, as well as by its much thickened margins. A certain soft, woolly appearance of

the surface is also characteristic. It seems to be a rare species in the recent state, having been noticed very sparingly only on the west of Scotland, in the Channel Islands, and Spitzbergen.

**DISTRIBUTION.** *Recent*.—Great Britain, Spitzbergen.

*Fossil*.—Scotland: Raised beach, Oban.

25. CYTHERE MACROPORA, *Bosquet*. Plate XIV, figs 1—3.

1852. CYTHERE MACROPORA, *Bosquet*. Entom. foss. terr. tertiair., p. 97, pl. v, fig. 2.

1856. — — — *Jones*. Monog. Tert. Entom., p. 35, pl. iii, figs. 9 a—9 c.

Carapace, as seen from the side, oblong, quadrangular, greatest height situated near the front and equal to more than half the length; anterior extremity somewhat obliquely rounded, and serrated below the middle; posterior subtruncate, its lower half somewhat produced and divided into five or six broad teeth; superior margin sloping nearly in a right line from before backwards; inferior nearly straight. Seen from above, the outline is oblong, subhexagonal, with irregularly parallel sides and broadly mucronate extremities, constricted in the middle. The surface of the shell is covered with deep, closely set angular pits, each valve bearing a large rounded central tubercle, and a strongly marked, rounded, encircling ridge just within the anterior, inferior and posterior margins; the central surface of each valve has on each side of the very prominent and largely developed contact-margins a single longitudinal series of large angular fossæ; the posterior portion of the contact-margins is ornamented in a similar manner.

Length,  $\frac{1}{3}$ th of an inch.

A handsome and very well characterised species, of which a few specimens only have occurred, from Hopton Cliff, Great Yarmouth. Professor Rupert Jones's measurement is double that given by M. Bosquet, with the latter of which ours closely agrees.

**DISTRIBUTION.** *Fossil*.—England: Post-tertiary, Hopton Cliff; Pliocene, Suffolk. France: Middle Eocene.

26. *CYTHERE CONCINNA*, Jones. Plate IV, figs. 1—16.1856. *CYTHERE CONCINNA*, Jones. Monog. Tert. Entom., p. 29, pl. iv, figs. 7 a—7 f.1865. *CYTHEREIS CLAVATA*, G. O. Sars. Overs. Norg. mar. Ostrac., p. 39.1868. *CYTHERE CONCINNA*, Brady. Monog. Rec. Brit. Ostrac., p. 408, pl. xxvi, figs. 28—33, and pl. xxxviii, fig. 7.

Carapace of the *female*, as seen from the side, oblong, subquadrangular, highest in front of the middle, greatest height equal to more than half the length; anterior extremity broadly rounded; posterior narrowed, obliquely subtruncate, sometimes emarginate in the middle (figs. 1, 5, 12), at others simple (fig. 6) or angularly produced (fig. 7); superior margin gibbous or prominently angular in front of the middle, thence sloping backwards with an irregularly curved or sinuous line; inferior margin straight or slightly sinuous. Outline, as seen from above, oblong-ovate, greatest width in the middle and equal to half the length; extremities obtuse, broad and nearly equal; lateral margins irregularly sinuous. End-view subpentagonal; height greater than the width. The carapace of the *male* is, as usual, considerably narrower and more elongated. The surface of the shell is subject to much variation in its sculpture.

The specimens represented at figs. 9 and 11 belong to the most strongly sculptured class, and exhibit the peculiar markings of the species with great distinctness; these consist of a prominent ridge running parallel to and a little within the anterior margin, and continued along the ventral border to the hinder end of the valve, a large rounded eminence a little below and in front of the centre of the valve and a flexuous rib running from the posterior margin of this tubercle towards the supero-posteal angle; the rest of the shell-surface is marked with small closely set puncta, and with minor ribs radiating from the larger ridges and tubercles; the posterior portion of the shell is also sometimes marked with distinct angular reticulations, as in fig. 9. Sometimes, however, the shell-sculpture is very feebly developed (fig. 6), the tubercles and ridges being very faintly indicated, the general surface obscurely pitted, and bearing a few short rigid hairs. Hinge-processes strongly developed.

Length,  $\frac{1}{8}$ th of an inch.

Between the simplest and the most elaborately sculptured forms all shades of variation may be found, and we have not been able to detect any constant relation between the varieties of sculpture and the geological position or other conditions of life; the most ornate and the most simple forms are found living in our own seas almost side by side, and have apparently existed in a similar manner in the seas of the Glacial Epoch. Various stages of growth are represented in figs. 13—16. *C. concinna* has been found in the recent state in the Arctic Sea, and on the coasts of Norway, Canada, Scotland, and north of England; its range of depth appears to be from ten to sixty fathoms.

DISTRIBUTION. *Recent.*—Great Britain, Ireland, Norway, Gulf of St. Lawrence, Spitzbergen, Davis's Straits.

*Fossil.*—England: Bridlington. Scotland: in nearly all the Post-tertiary beds. Ireland: Woodburn, and New Docks, Belfast. Canada and Norway. Post-tertiary beds.

27. CYTHERE EMACIATA, *Brady*. Plate IX, figs. 14—17.

1866. CYTHERE EMACIATA, *Brady*. Brit. Assoc. Report, p. 210.

1868. — — *Brady*. Monog. Rec. Brit. Ostrac., p. 414, pl. xxxi, figs. 31—37.

Carapace (of the *male*?), as seen from the side, oblong, subquadrate, greatest height situated in front and not equalling half the length. Anterior extremity forming a somewhat flattened curve and faintly toothed below; posterior rather narrower, obliquely concave above the middle and produced below into four or five short blunt teeth; superior margin sloping backwards almost in a straight line; inferior very slightly sinuated. Outline, as seen from above, compressed ovate, nearly thrice as long as broad; sides nearly parallel; anterior extremity obtuse and centrally emarginate; posterior broadly emarginate in the middle and produced on each side into a more or less conspicuous spinous lobe. Surface of the valves marked with two or three prominent longitudinal ribs, which towards the anterior extremity anastomose, forming a network of large polygonal areolæ; the remainder of the shell is covered with large and deep subcircular excavations, which are arranged chiefly in longitudinal rows. The dorsal aspect shows a deep sulcus in the line of the hinge-margins, and the contact-margins on the ventral surface are considerably introverted and bordered by a wide smooth band.

Length,  $\frac{1}{3}$ rd of an inch.

*Cythere emaciata* occurs in the living state in depths of ten to thirty fathoms on the southern shore of England, and the west of Ireland and Scotland; the Scottish specimens, however, being few and stunted in growth.

DISTRIBUTION. *Recent.*—Great Britain and Ireland.

*Fossil.*—Raised beaches, Oban and Portrush.

28. CYTHERE QUADRIDENTATA, *Baird*. Plate XIII, fig. 22.

1850. CYTHERE QUADRIDENTATA, *Baird*. Brit. Entom., p. 173, pl. xxi, fig. 2.

1868. — — *Brady*. Monog. Rec. Brit. Ostrac., p. 413, pl. xxxi, figs. 19—30.

Carapace, as seen from the side, oblong, quadrangular, or subcuneate, highest in front, height equal to about half the length. Anterior extremity obliquely rounded, often bearing a row of from eight to twelve small teeth; posterior extremity narrowed, angular, excavated above and considerably produced below, where it is generally armed with about four sharp spines: inferior margin straight or slightly convex; superior elevated over the anterior hinge, thence sloping backwards. Seen from above, oblong-ovate or hastate, greatest width situated behind the middle and equal to less than half the length, the junction of the hinge-margins marked behind the middle by a deep, sharply defined sulcus; ventral surface depressed along the whole length of the contact-margins, which are bordered by a broad, well defined, smooth band. Surface of the shell marked with oblong punctures, which are arranged chiefly in longitudinal rows, but around the anterior border in curved lines. The valves are usually swollen behind, forming an abrupt angular elevation, from which a longitudinal rib runs directly forwards, and two others in an oblique direction towards the upper and lower margins. Left valve considerably smaller than the right.

Length,  $\frac{1}{3}$ rd of an inch.

We have met with only one fossil specimen of this species, and from it our figure is taken; but, as this carapace is by no means well characterized, our description is taken from recent specimens.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Bay of Biscay.

*Fossil*.—Scotland: Loch Gilp.

29. CYTHERE ANGULATA (*G. O. Sars*). Plate IV, figs. 17—24; and Plate X, fig. 22.

1865. CYTHEREIS ANGULATA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 40.

1865. CYTHERE CLATHRATA, *var. NUDA*, *Brady*. Zool. Trans., vol. v, p. 377, pl. liz, figs. 9, 10.

1868. — ANGULATA, *Brady*. Monog. Rec. Brit. Ostrac., p. 409, pl. xxvi, figs. 39—42.

Carapace of the *female*, as seen from the side, oblong, subquadrangular, greatest height over the anterior hinge and equal to more than half the length. Anterior extremity broadly and somewhat obliquely rounded, traversed by numerous radiating hair-like lines; posterior subtruncate, projecting angularly in the middle, its lower half produced backwards and often divided into four or five small teeth; upper margin highest over the anterior hinge, thence sloping with a slight convexity to the posterior extremity, where it ends in an obtuse angle; inferior straight or only slightly sinuated. Outline, as seen from above, oblong, subhexagonal; sides nearly parallel and more or less constricted in the middle; extremities abruptly tapered, obtuse; margins irregularly sinuous; twice as long as broad; hinge-line marked on the dorsal aspect by a deep,

sharply cut sulcus. Shell-surface bearing a few distant, short, rigid hairs, and ornamented with large, deep, angular excavations, mostly arranged in irregularly waved or radiating lines; there is usually a conspicuous rounded tubercle a little below and in front of the centre of the valve, and two broad, rounded, and elevated ridges, one running parallel with the ventral, the other with the dorsal margin, on the posterior half of the valve; these are confluent behind, ending abruptly and thus forming a well-marked transverse ridge or declivity; there is also a narrow elevated ridge running parallel to and within the anterior margin.

Length,  $\frac{1}{40}$ th of an inch.

This species, like *C. concinna*, varies much in the amount of sculpture visible on its valves, some specimens, as shown in fig. 17, being poorly marked, while others, of which fig. 21 is a fair example, are very highly ornamented. In the British seas, at the present day, it seems to be of rare occurrence, and confined to the northern and western shores of Scotland, where it lives in considerable depths of water. It has been found also by G. O. Sars on the coast of Norway.

DISTRIBUTION. *Recent*.—Baffin's Bay, Norway; Great Britain, Davis's Straits.

*Fossil*.—England: Bridlington. Scotland: nearly all the clay beds of the Clyde district; Raised beach, Oban; Drip Bridge. Ireland: Portrush. Norway.

30. CYTHERE LATIMARGINATA, *Speyer*. Plate XVI, fig. 6.

1863. CYTHERE LATIMARGINATA, *Speyer*. Die Ostrac. der Casseler Tertiärbild., p. 22, pl. iii, figs. 3 a—d.

1865. — ABYSSICOLA, G. O. Sars. Overs. Norg. mar. Ostrac., p. 43.

Shell of the *female*, as seen from the side, elongated, subquadrangular, much higher in front than behind, greatest height not more than half the length; anterior extremity obliquely rounded; posterior truncate; superior margin very prominent and angulated above the eyes, slightly concave in the middle, then convex, and steeply sloping towards the hinder end; inferior distinctly sinuated in the middle. Seen from above, of irregular form, showing on each lateral margin two subangular protuberances separated by a deep furrow, both extremities being a little produced and truncate. Valves very hard in structure, indistinctly areolated in the middle, surrounded by a wide and much thickened margin, which forms two lips, the innermost of which is at each extremity minutely dentate, and especially towards the posterior extremity is beset with rather long hairs. Hinge-teeth of the left valve obsolete.

Length,  $\frac{1}{30}$ th of an inch.

One valve only of this species has come under our notice, from Hopton Cliff, near Yarmouth, and, this being imperfect we have had recourse for our description to the



original account given by G. O. Sars. Our figure, however, is copied accurately from the Hopton Cliff specimen.

Judging from the carefully drawn figures of Dr. Speyer, which, though too small, offer a delightful contrast to the almost useless illustrations of fossil *Ostracoda* usually produced in Germany, we have no doubt that his *Cythere latimarginata* really refers to the species better known to us by the more recent description (from the living animal) of Sars under the name *abyssicola*. On the ground of priority, however, we here adopt Speyer's specific name.

DISTRIBUTION. *Recent*.—Norway and Shetland.

*Fossil*.—England: Hopton Cliff. Germany: Middle Tertiary, Cassel.

31. *CYTHERE TUBERCULATA* (G. O. Sars). Plate V, figs 7—12.

1865. *CYTHEREIS TUBERCULATA*, G. O. Sars. Overs. Norg. mar. Ostrac., p. 37.

1865. *CYTHERE MUTABILIS*, CLATHRATA, *var.* LYRATA, et ? *var.* LATIMARGINATA, Brady. Trans. Zool. Soc., p. 377, pl. lix, figs. 12, 13, 14.

1868. — *TUBERCULATA*, Brady. Monog. Rec. Brit. Ostrac., p. 406, pl. xxx, figs. 25—41 (not *Cytherideis tuberculata* of Jones, Monog. Tert. Entom., p. 47).

Carapace of the *female*, as seen from the side, oblong, subquadrangular or subovate, highest over the anterior hinge; greatest height equal to rather more than half the length. Anterior extremity broad, obliquely rounded, and fringed on its lower half with a series of (12—20) short equal teeth; posterior extremity narrower, evenly rounded and bearing usually near the lower angle four, five, or six teeth rather larger than, but of similar character to, those on the anterior margin. Superior margin sinuated behind the anterior hinge, thence sloping backwards with an irregularly sinuous (or sometimes twice or thrice sharply emarginate) curve; inferior margin gently sinuated in the middle. Outline, as seen from above, ovate, widest in the middle, extremities evenly and somewhat obtusely pointed, margins irregularly sinuous, width scarcely equalling half the length. End-view irregularly and broadly ovate, height not much exceeding the width. Carapace of the *male* (fig. 11) much narrower and more elongated, dorsal margin more conspicuously angulated at each extremity, ventral margin more deeply sinuated. Surface of the shell marked throughout with large, deep, irregularly shaped pittings, the interspaces of which often bear a few scattered setiferous papillæ, bearing also three more or less conspicuous eminences, one rounded and situated near the middle, the others elongated and occupying the posterior third of the valve; these, especially the two posterior, are often almost obsolete.

Length,  $\frac{1}{8}$ th of an inch.

*Cythere tuberculata* is one of the commonest and most widely distributed of living British Ostracoda, occurring chiefly in depths of 10—30 fathoms. Like its near allies, *C. concinna*, *angulata*, *quadridentata*, &c., it exhibits much variation in outline and in surface-marking, and, as also in those species, the tubercular elevations are much more conspicuous in very young than in old specimens, though the contrary holds good with regard to the pitting or excavation of the shell.

**DISTRIBUTION.** *Recent.*—Baffin's Bay, Great Britain, Ireland, Norway, Spitzbergen, Bay of Biscay, West Indies, Gulf of St. Lawrence.

*Fossil.*—Occurring in nearly all the Post-tertiary beds in the Clyde district; on the east of Scotland, Gamrie, Annochie, King Edward, Wick, Drip Bridge. England: Bridlington, Hopton Cliff, Branston Fen. South Wales: Cardiff New Dock Basin. Ireland: Woodburn, Belfast New Docks. Norway, Post-tertiary beds.

32. CYTHERE LOGANI, *Brady and Crosskey*. Plate XV, figs. 17, 18.

1871. CYTHERE LOGANI, *Brady and Crosskey*. *Geol. Mag.*, vol. viii, p. 63, pl. ii, figs. 8—9.

Shell, seen laterally, subquadrate, highest in front, greatest height equal to more than half the length; anterior extremity broadly and well rounded; posterior narrower and obliquely rounded; superior margin straight in its general direction, but much jagged and emarginate throughout, terminating in an obtuse angle behind; inferior slightly sinuated, curved upwards towards the posterior extremity. Seen from above, the outline is irregularly ovate, with obtusely rounded extremities. Surface of the valves marked with large and deep angular fossæ, near the middle bearing a rounded tubercle and near the posterior extremity two large tubercular elevations.

Length,  $\frac{1}{8}$ th of an inch.

It is not without hesitation that we identify the single valve on which the foregoing description is founded with *C. Logani*; yet, though the contour of the shell differs in some not unimportant particulars from the types of that species, its general aspect and style of sculpture are so nearly similar that we think it best, for the present at least, to consider it as belonging to the same species.

**DISTRIBUTION.** *Fossil.*—Scotland: Elie. Canada: Montreal.

33. *CYTHERE EMARGINATA* (*G. O. Sars*). Plate V, figs. 1—6.1865. *CYTHEREIS EMARGINATA*, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 38.1868. *CYTHERE* — *Brady*. Monog. Rec. Brit. Ostrac., p. 475.

Carapace of the *female*, as seen from the side, subreniform, highest in the middle, greatest height equal to considerably more than half the length. Anterior extremity obliquely rounded; posterior produced below into a prominent angular lobe; superior margin boldly arched, highest in the middle; inferior slightly sinuated in front of the middle and curved upwards behind. Outline, as seen from above, compressed, ovate, extremities obtusely mucronate. The right valve very different from the left, higher and more boldly arched, sinuated in front of the anterior hinge; posterior extremity more deeply emarginate, and more prominent below. The carapace of the *male* is distinctly quadrangular, its greatest height little exceeding half the length and situated over the anterior hinge; superior margin only slightly curved; posterior obliquely truncate. Surface of the valves irregularly sculptured with large angular excavations, which behind terminate abruptly in a transverse ridge a little in front of the posterior margin, and below in a sharply defined ventral rib, which is most strongly developed posteriorly. Hinge-line on the dorsal surface marked by a deep, sharply cut sulcus; hinge-teeth strongly developed.

Length,  $\frac{1}{30}$ th of an inch.

DISTRIBUTION. *Recent*.—Arctic Seas, Norway, Shetland, Iceland, Spitzbergen, Gulf of St. Lawrence.

*Fossil*.—England: Bridlington. Scotland: Barrie, Elie, Errol. Ireland: Portrush. Norway and Canada.

34. *CYTHERE COSTATA*, *Brady*. Plate V, figs. 21—24.1865. *CYTHERE COSTATA*, *Brady*. Trans. Zool. Soc. vol. v, p. 375, pl. lx, figs. 5 a—f.1869. — — *Norman*. Brit. Assoc. Report, 1868, p. 290.

Carapace of the *female*, as seen from the side, subquadrangular, highest in front of the middle, greatest height equal to somewhat more than half the length. Anterior extremity subtruncate, emarginate above, produced below, and divided into four or five short obtuse teeth; superior margin arched, gently sinuated in front. Outline, as seen

from above, ovate, widest in the middle; extremities obtusely mucronate, margins irregular. The carapace of the *male* is longer, narrower, and distinctly quadrangular, its greatest height situated in front and equal to less than half the length; superior margin distinctly angular over the anterior hinge, behind which it is slightly excavated, and then slopes backwards almost in a straight line; posterior margin obliquely truncate. Shell-surface deeply marked with irregular angular excavations, and with three or more prominent obliquely transverse ribs. Hinge-teeth strongly developed.

Length,  $\frac{1}{8}$ th of an inch.

*C. costata* has been found living amongst the Shetland Islands and in Baffin's Bay, at a depth of 60—70 fathoms. It is very nearly allied to *C. emarginata*, being distinguished from that species chiefly by its greater size and narrower proportions, as well as by its prominent oblique ridges, and the dentation of its infero-posterior angle.

DISTRIBUTION. *Recent*.—Arctic Seas, Shetland, Gulf of St. Lawrence.

*Fossil*.—England: Bridlington, Hopton Cliff. Scotland: Paisley.

35. CYTHERE MIRABILIS, *Brady*. Plate VII, figs. 22—26; Plate XV, figs. 13—16.

1868. CYTHERE MIRABILIS, *Brady*. Monog. Rec. Brit. Ostrac., p. 415, pl. xxix, figs. 7, 8.

Carapace of the *female*, as seen from the side, subtrapezoidal, highest at the anterior third, greatest height equal to two thirds of the length. Anterior extremity broad, boldly rounded, and bordered below with a series of ten to twenty short, blunt spines; posterior narrow, truncate, bearing about four blunt spines at its inferior angle. Superior margin prominently angular over the anterior hinge, behind which it is two or three times deeply and abruptly excavated, thence sloping with a steep, irregularly jagged curve to the posterior extremity, where it ends in an obtuse angle; inferior margin gently and evenly convex. Outline, as seen from above, ovate, with flattened sides, width equal to more than half the length: posterior extremity rounded, prominent in the middle, and bearing numerous sharp, irregularly placed spines; anterior margin obtuse, irregularly denticulate or spinous. Surface of the shell sculptured on the central and centro-dorsal portions with large, deep, and sharply cut polygonal excavations, and round the margins with wide, concentric furrows, which are separated from each other by sharp ribs, sparingly anastomosing, and especially strong and prominent on the ventral surface. Hinge-joint formed on the left valve by a very strong central bar, terminating anteriorly in a prominent tooth, and posteriorly in a sharply defined sulcus; on the right valve by two very large terminal teeth, the anterior of which is triangular

and fang-like; the posterior broad and obliquely truncate. The shell of the *male* is, as usual, more compressed and elongated.

Length,  $\frac{1}{3}$ rd of an inch.

DISTRIBUTION. *Recent*.—Scotland, Spitzbergen.

*Fossil*.—England: Bridlington. Scotland: Barrie, Elie, Dryleys, Errol, Wick.

36. *CYTHERE HOPTONENSIS*, *nov. sp.* Plate XIV, figs. 4—6.

Left valve, as seen from the side, subquadrangular, oblong, greatest height situated over the anterior hinge-tubercle, and equal to nearly two thirds of the length; anterior extremity obliquely rounded; posterior subtruncate, prominent and rounded below the middle; superior margin sloping from before backwards and distinctly excavated towards each extremity; inferior nearly straight; seen from above, the outline is irregularly ovate, with broadly and obtusely mucronate extremities. The outline of the right valve presents an evenly arched, though flattened dorsal margin, the lower angle of the posterior margin being also much more distinctly produced. The surface of the shell is covered with rather sharp and irregularly convoluted ridges, and with distinct crests running parallel to the anterior and lower borders.

Length,  $\frac{1}{3}$ rd of an inch.

DISTRIBUTION, *fossil*.—England: Hopton Cliff.

37. *CYTHERE DUNELMENSIS* (*Norman*). Plate V, figs. 13—20; Plate XI, figs. 36, 37.

1865. *CYTHEREIS DUNELMENSIS*, *Norman*. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 22, pl. vii, figs. 1—4.

1865. — *HOBRIDA*, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 45.

1868. *CYTHERE DUNELMENSIS*, *Brady*. Monog. Rec. Brit. Ostrac., p. 416, pl. xxx, figs. 1—12.

Carapace of the *female*, as seen from the side, subquadrangular, greatest height equal to more than half the length, and situated over the anterior hinge. Anterior extremity broadly rounded; posterior somewhat narrower and rectangularly truncate; superior margin nearly straight, highest in front; inferior slightly sinuated, the whole circumference being much jagged and spinous. Outline, as seen from above, ovate, extremities

obtuse. The shell of the *male* is longer, narrower, and distinctly quadrangular, and its infero-posteal angle is produced into a more or less conspicuous squamous and spinous plate. The surface of the shell is marked by large subhexagonal excavations, the intervals between which are beset with several strong spines of irregular shape and size, which are much larger in the male than in the female; there is also a row of spinous tubercles parallel to and a little within the anterior margin, the series being continued with less regularity along the greater part of the ventral margin. Hinge-tubercles large, shining, and prominent, especially in the male. Hinge-teeth very strongly developed, shell very thick and strong.

Length,  $\frac{1}{8}$ th of an inch.

*Cythere Dunelmensis* is not very rare in the living state in the seas of Norway, Scotland, and Northern England, mostly inhabiting depths of fifteen fathoms and upwards. The reticulation of the surface is often obscure, and its spinous armature is very variable in strength and general development. Young specimens (fig. 19) are sub-ovate in form, with the margins arched and the angles well rounded off. The form figured in Plate XI, figs. 36, 37, which we at one time supposed to belong to a distinct species, is without doubt the young stage of *C. Dunelmensis*; between this and the adult form almost all gradations of growth have been observed.

DISTRIBUTION. *Recent*.—Great Britain and Ireland, Gulf of St. Lawrence, Arctic Seas, Spitzbergen.

*Fossil*.—England: Bridlington. Scotland: nearly all the Post-tertiary beds. Ireland: Belfast and Woodburn.

### 38. CYTHERE WHITEI (*Baird*). Plate XII, figs. 1—3.

1850. CYTHEREIS WHITEI, *Baird*. Brit. Entom., p. 175, pl. xx, figs. 3, 3 a.

1868. CYTHERE — *Brady*. Monog. Rec. Brit. Ostrac., p. 416, pl. xxx, figs. 21—24.

Carapace, as seen from the side, oblong, quadrangular, nearly equal in height throughout, height equal to half the length; anterior margin rounded and more or less spinous, conspicuously elevated over the anterior hinge-joint; posterior almost rectangularly truncate, and mostly bearing two or more large backward-pointing spines at its lower termination; superior and inferior margins almost straight, but more or less bluntly toothed behind the middle. Seen from above, the outline is ovate, widest behind the middle, the greatest width being somewhat less than the height, only slightly tapering towards the broadly mucronate or subtruncate extremities. The valves are ornamented

with three or four longitudinal rows (more or less interrupted) of blunt rounded spines, and between the rows are a few smaller scattered tubercles of similar character.

Length,  $\frac{1}{8}$ th of an inch.

In the recent state this is, perhaps, almost the rarest of the strongly spinous species of *Cythere*, which are represented more commonly by *C. Dunelmensis*, *Jonesii*, and *antiquata*. In those localities where it has been noticed the number of examples found has been extremely small, and the same remark applies to the fossil specimens.

DISTRIBUTION. *Recent*.—Great Britain, Levant, Gulf of St. Lawrence.

*Fossil*.—Belfast New Docks.

39. CYTHERE ANTIQUATA (*Baird*). Plate XII, figs. 8—10.

1850. CYTHEREIS ANTIQUATA, *Baird*. Brit. Entom., p. 176, pl. xx, fig. 2.

1868. CYTHERE ANTIQUATA, *Brady*. Monog. Rec. Brit. Ostr., p. 417, pl. xxx, figs. 17—20.

Carapace, as seen from the side, rectangular, quadrilateral, about equal in height throughout, length equal to nearly twice the height; anterior extremity broadly rounded; posterior rectangularly truncate, both extremities spinous below the middle, the spines of the posterior much longer and stronger than those of the anterior margin; superior and inferior margins parallel, the latter almost straight, the former cleft into three or four angular segments with intervening sulci and forming an angular elevation over the anterior hinge. Seen from below, oblong with projecting lateral alæ, which taper towards the front, but terminate abruptly behind, giving to the whole a somewhat arrow-headed outline. From above the outline is more irregular. Surface of the shell more or less tuberculated, bearing two conspicuous longitudinal crests, which terminate abruptly in angular elevations near the posterior extremity of the valves; these ribs are mostly perforated at the base, the rows of apertures thus produced being very conspicuous on the ventral aspect of the shell. The "eye-tubercle" is very large and prominent.

Length,  $\frac{1}{8}$ th of an inch.

The characters which chiefly distinguish this from the much rarer species *C. Whiteii* are the more marked rectangular outline, the sharply cut, knife-like, and perforated longitudinal ridges, and the much lacinated or jagged dorsal margin.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Bay of Biscay, Levant.

*Fossil*.—Scotland: Raised beach, Oban. Ireland: Belfast New Docks.

40. *CYTHERE JONESII* (*Baird*). Plate XII, figs. 4—7.

1850. *CYTHEREIS JONESII*, *Baird*. Brit. Entom., p. 175, pl. xx, fig. 1; Norman (1865), Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 21, pl. vii, figs. 5—8.
1852. *CYTHERE CERATOPTERA*, *Bosquet*. Entom. foss. terr. tert. France, p. 114, pl. vi, fig. 2; Jones (1856), Monog. Tert. Entom., p. 39, pl. iv, fig. 1.
1856. ? *CYTHEREIS CORNUTA* (young), *Jones*. Monog. Tert. Entom., p. 39, pl. iv, fig. 19.
1862. — *FIMBRIATA*, *Norman*. Ann. Mag. N. H., ser. iii, vol. ix, pl. iii, fig. 9.
1865. — *SPECTABILIS*, *Sars*. Overs. Norg. mar. Ostrac., p. 46.
1865. — *SUBCORONATA*, *Brady*. Trans. Zool. Soc., vol. v, p. 384, pl. lx, figs. 9 *a—c*, and (?) *Speyer* (1863), Ostrac. Casseler Tertiärbild., p. 38, pl. iv, figs. 9, 10.
1868. *CYTHERE JONESII*, *Brady*. Monog. Rec. Brit. Ostrac., p. 418, pl. xxx, figs. 13—16.

Carapace, as seen from the side, ear-shaped or subquadrangular, higher in front than behind, greatest height considerably more than half the length; anterior margin rounded, fringed with blunt spines below the middle; posterior subtruncate, armed with a series of strong spines which are largest towards the ventral angle; inferior margin gently convex; superior much shorter than the inferior, sloping gently from before backwards, its anterior extremity forming a conspicuous angular elevation: Outline, as seen from below, irregularly lozenge-shaped or subrhomboidal, bordered with strong spinous projections, which gradually increase in size from the front to the posterior third, where they terminate abruptly; greatest width equal to two thirds of the length, situated behind the middle. End-view triangular, equilateral; the base perfectly straight. The surface of the shell is quite smooth and rises gradually from the front to near the posterior extremity of the valves, there forming an abrupt spinous declivity. A strongly developed ridge commences at the anterior hinge or "eye-tubercle," running a little within and parallel to the anterior and inferior margins, as far as the transverse declivity just described; this ridge is in the first portion of its course smooth and rounded, but near the middle of the anterior margin becomes spinous and retains that character to the end, the spines of which it is composed being about ten in number, very large and strong, rounded at the tips; a little below and behind the middle of the superior margin is a shorter row of similar strong processes, three or four in number and arranged longitudinally.

Length,  $\frac{1}{8}$ th of an inch.



*Var. CERATOPTERA* (Plate XII, fig. 7).

This differs from the typical form of the species, only in the greater delicacy of its shell-structure and the more attenuated condition of its spinous armature. Our fossil specimens, of which fig. 7 gives a correct idea, do not exhibit these peculiarities so conspicuously as do recent carapaces dredged in the west of Ireland, or more especially in the Mediterranean and Bay of Biscay; but between the extreme forms of these latter localities and the robust strongly armed carapaces of the Dogger bank and still more northern habitats—which we look upon as constituting the typical *C. Jonesii*—every grade of development may be met with.

**DISTRIBUTION.** *Recent.*—Norway, Great Britain.—(var. *ceratoptera*), Ireland, Bay of Biscay, Levant.

*Fossil.*—Ireland: Post-tertiary, Belfast New Docks (var.). England: Pliocene, Suffolk. Belgium and France: Eocene.

41. *CYTHERE* (?) *SEMIPUNCTATA*, *Brady*. Plate XVI, figs. 11, 12.

1868. *CYTHERE* (?) *SEMIPUNCTATA*, *Brady*. *Monog. Rec. Brit. Ostrac.*, p. 411, pl. xxix, figs. 33—38.

Carapace, as seen from the side, subreniform, nearly equal in height throughout, height equal to fully half the length, extremities well and evenly rounded; superior margin very slightly arched; inferior gently sinuated in the middle. Seen from above, compressed, oblong, width equal to one third of the length, lateral margins nearly parallel, extremities produced and broadly truncate. Shell thick, smooth in front, but behind the middle covered with rounded and rather large impressed puncta. Within the anterior and inferior margins the valves are hollowed out so as to form a wide channel, the margins themselves being thickened and everted.

Length,  $\frac{1}{80}$ th of an inch.

**DISTRIBUTION.** *Recent.*—Bay of Biscay, England, and Ireland.

*Fossil.*—Scotland: Raised-beach, Oban.

*Genus 2.*—LIMNICY THERE, *Brady*.

Shell irregularly tuberculated or spinous, rather thin and horny in texture. Animal like that of *Cythere*, except that the antennæ are armed with short setæ, instead of spines. Upper antennæ five-jointed, slender, the last joint much elongated, the antepenultimate excessively short. Post-abdomen terminating in two rather stout setæ.

Freshwater habitat.

1. LIMNICY THERE INOPINATA (*Baird*). Plate X, figs. 8—11.

1850. CYTHERE INOPINATA, *Baird*. Brit. Entom., p. 172, pl. xx, figs. 1, 1 *a—e*.

1868. LIMNICY THERE — *Brady*. Monog. Rec. Brit. Ostrac., p. 419, pl. xxix, figs. 15—18; pl. xxxviii, fig. 9; pl. xxxix, fig. 1.

Carapace, as seen from the side, reniform, greatest height near the middle and somewhat exceeding half the length; anterior extremity evenly, posterior obliquely rounded, and fringed below the middle with a series of from six to twelve small sharp teeth; superior margin forming a flattened arch, inferior deeply sinuated in the middle. Seen from above, the outline is irregularly ovate, conspicuously and sharply mucronate in front and more obscurely behind; greatest width behind the middle, and scarcely equal to half the length. Surface of the valves finely punctate, once or twice transversely sulcate, and usually bearing from one to three tubercles; margins produced into a compressed encircling flange. Colour yellowish.

Length,  $\frac{1}{4}$ th of an inch.

The tuberculation and general surface-sculpture of this species vary very much; sometimes, as in the specimen here figured, there is scarcely any tuberculation; in other cases there may be one, two, or three tubercles, which of course very much modify the outline of the shell when viewed from above. Our fossil specimens, however, are as a general rule less uneven than the recent ones.

DISTRIBUTION. *Recent*.—Great Britain, Ireland.

*Fossil*.—Scotland: Crofthead, Dipple. England: Hornsea, Branston Fen.

2. *LIMNICY THERE? ANTIQUA*, *nov. sp.* Plate XVI, figs. 4, 5.

Carapace, as seen from the side, oblong, subreniform, higher in front than behind, height equal to half the length. Extremities well and evenly rounded, the posterior much the smaller; superior margin sloping almost in a right line from before backwards, inferior deeply and suddenly sinuated in the middle; seen from above, compressed ovate, with slender acuminate extremities, greatest width a little in front of the middle, and equal to one third of the length. Shells marked with a faintly striato-reticulate pattern and with a bicurvate transverse furrow near the middle of the valve.

Length,  $\frac{1}{10}$ th of an inch.

It may perhaps be doubted whether this form be not referable to the young or some local variety of the foregoing species; its chief distinctive characters are the narrowed posterior extremity, straight dorsal margin, and faint surface-sculpture, just such as are usually presented by young shells, but we have not as yet seen any distinctly intermediate forms, nor are we sure as to the young of the recent *L. inopinata*.

DISTRIBUTION. *Fossil*.—Scotland: Crofthead, Terally, Dipple.

3. *LIMNICY THERE SANCTI-PATRICII*, *Brady and Robertson*. Plate II, figs. 1—3.

1869. *LIMNICY THERE SANCTI-PATRICII*, *B. and R.* Ann. Mag. N. H., ser. iii, vol. iv, pl. xviii, figs. 8—11; pl. xxi, fig. 4.

Carapace (of the *male?*), as seen from the side, reniform, nearly equal in height throughout, height equal to half the length; extremities well rounded, the anterior slightly the broader; superior margin almost straight, inferior deeply sinuated in the middle. Seen from above, the outline is irregularly rhomboidal, widest somewhat behind the middle; extremities acuminate; greatest width rather less than the height. Seen from the front, the outline is widest at the base, with gradually converging sides and broadly arched apex; ventral margin convex, and prominently keeled in the middle. Surface of the valves sculptured with small, closely set, polygonal excavations, and marked across the middle with a conspicuous broad and deep curved furrow, in front of which is another, of similar character, but smaller; behind the posterior furrow the shell rises towards the ventral surface into a prominent rounded eminence: the ventral surface is furrowed in a longitudinal direction, and also marked more or less with cross striæ.

DISTRIBUTION. *Recent*.—Great Britain, Ireland.

*Fossil*.—England: Branston Fen, Lincolnshire.

4. LIMNICY THERE MONSTRIFICA (*Norman*). Plate II, figs. 8 *a—d*.

1862. CYPRI MONSTRIFICA, *Norman*. Ann. Mag. N. H., vol. ix, p. 45, pl. iii, figs. 4, 5.

1868. LIMNICY THERE — *Brady*. Monog. Rec. Brit. Ostrac., p. 420, pl. xxix, figs. 9—12.

Valves, as seen from the side, oblong, subreniform, strongly spinous and tuberculated, greatest height near the middle, and equal to about half the length. Extremities boldly rounded, the anterior bearing on each valve a marginal row of about twelve small sharp spines. Superior margin straight, angulated at its anterior extremity, whence it slopes gently downwards and backwards; inferior margin deeply sinuated. Seen from above, compressed, irregularly ovate, lateral margins having two large spinous processes, and several smaller spines and ridges; extremities prominently mucronate. End-view subquadrate, irregularly angulated. Valves closely punctate, furrowed across the middle; one strong spinous tubercle on the anterior, and two on the posterior half of each valve; posterior portion also beset with numerous small spines.

Length,  $\frac{1}{3}$ rd of an inch.

DISTRIBUTION. *Recent*.—England.

*Fossil*.—England: Branston Fen, Lincolnshire.

Genus 3.—CYTHERIDEA, *Bosquet*.

Valves unequal, the left mostly larger than the right, ovate or subtriangular, highest at the anterior third. Surface smooth, or marked with scattered circular tubercles, impressed puncta, or concentric furrows, anterior extremity rarely spinous, posterior sometimes bearing a single spine at its inferior angle. Lucid spots arranged in a transverse row of three or four, with two detached, sometimes coalescent, spots in front. Hinge composed of two crenated or "knurled" crests on the left (sometimes the right) valve which articulate with corresponding depressions of the opposite valve. Upper antennæ very robust, mostly five-jointed, and bearing strong spines; the last joint narrow and elongated; lower antennæ four-jointed; urticating setæ long and slender, biarticulate. Mandibles large and numerously toothed; palp three-jointed, and bearing a distinct branchial appendage. The right foot of the first and second pairs in the male different

from the rest, that of the first pair very strong and prehensile ; of the second very feeble, the apical portion rudimentary and destitute of a terminal claw. Eyes distinct.

We include in this genus the species referred by Prof. T. Rupert Jones and G. O. Sars to *Cyprideis*, as we are unable to find any sufficient character to distinguish these from the typical *Cytheridea* of M. Bosquet. Sars proposes to confine the generic term *Cytheridea* to the form typified by his *C. dentata* ; but the animal structure of [this species is quite unknown, and the shell does not appear to exhibit any marked differentiating character ; the difference seems to us to be one of degree merely.

Certain species of *Cytheridea* are very abundant and widely distributed in the seas of the present day, but the number of species is comparatively few. Most of the forms described in this Monograph are, however, still flourishing in the British areas.

1. CYTHERIDEA PAPILLOSA, *Bosquet*. Plate VI, figs. 12—15.

1852. CYTHERIDEA PAPILLOSA, *Bosquet*. Entom. foss. terr. tertiair. France, p. 42, pl. ii, fig. 5.  
 1865. CYTHERE BRADII, *Norman*. Nat. Hist. Trans. Northumb. and Durham, vol. i, p. 15, pl. v, figs. 5—8 ; see also note, p. 28.  
 1865. CYPRIDEIS BAIRDII, *G. O. Sars*. Oversigt af Norges marine Ostracoder, p. 52.  
 1865. CYTHERIDEA PAPILLOSA, *Brady*. On new or imperfectly known species of Marine Ostracoda ; Trans. Zool. Soc., vol. v, p. 370, pl. lviii, figs. 8 a—g.  
 1868. — — — *Brady*. Monog. Rec. Brit. Ostrac., Trans. Lin. Soc., vol. xxvi, p. 423, pl. xxviii, figs. 1—6, pl. xl, fig. 1.

Carapace of the *female*, as seen from the side, subovate, highest near the middle ; greatest height equal to rather more than half the length. Anterior extremity evenly, posterior obliquely rounded. Superior margin well arched, forming a continuous curve as far as the infero-posteal angle of the carapace, inferior margin slightly sinuated in the middle, the infero-posteal angle more exerted. Outline, as seen from above, ovate, widest behind the middle, greatest width equal to half the length ; end-view nearly circular ; surface of the shell smooth and polished, bearing numerous scattered circular tubercles or papillæ, and sometimes slightly punctate. Lucid spots large and conspicuous.

The shell of the *male* is narrower and more elongated, and its dorsal margin is much flattened and nearly parallel with the ventral.

Length,  $\frac{1}{30}$ th of an inch.

This species has been already identified by one of us with M. Bosquet's *Cytheridea*

*papillosa*; and though the British specimens, both recent and fossil, are considerably larger than those obligingly sent to us from France by M. Bosquet, they so perfectly agree in every other respect that we can scarcely do otherwise than adopt the name *papillosa* already applied to them by Mr. Brady. In habitat it ranges from extreme low-water-mark to twenty or thirty fathoms, and is also found, but much less abundantly, in greater depths of water.

DISTRIBUTION. *Recent*.—Baffin's Bay, Gulf of St. Lawrence, Norway, Spitzbergen, Great Britain.

*Fossil*.—England: Bridlington. Scotland: nearly all the Post-tertiary beds. Norway and Canada: Post-tertiary beds. France: Tertiary.

## 2. CYTHERIDEA PUNCTILLATA, *Brady*. Plate VI, figs. 1—11.

1865. CYTHERIDEA PUNCTILLATA, *Brady*. Ann. Mag. Nat. Hist., ser. iii, vol. xvi, p. 189, pl. ix, figs. 9—11. 1868, Monog. Brit. Ostrac., p. 424, pl. xxvi, figs. 35—38; pl. xxviii, figs. 17—20.

1865. CYPRIDEIS PROXIMA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 54.

Carapace of the *female*, as seen from the side, subovate, highest in front of the middle, greatest height equal to more than half the length. Anterior extremity broadly and evenly, posterior somewhat obliquely rounded; superior margin highest over the anterior hinge, where it is obscurely angular, thence sloping backwards with a gentle convexity; inferior straight or very slightly sinuated in the middle. Outline, as seen from above, ovate, greatest width in the middle, and equal to half the length; extremities obtusely pointed; end-view nearly circular. The carapace of the *male* (fig. 4) is much longer, narrower, and more angular, the posterior margin of the right valve sloping abruptly in a subtruncate manner. Surface of the shell thickly covered with impressed puncta, which have a tendency to coalesce or to form faintly-marked grooves. Specimens from certain localities (Jordan Hill, &c.) bear also numerous small circular elevated papillæ; in young specimens these constitute the only markings, but are displaced by the pitted sculpture as age advances. Many examples are profusely marked with both species of sculpture. Colour yellowish-brown.

Length,  $\frac{1}{8}$ th of an inch.

*Cytheridea punctillata* occurs in the living state on the shores of Britain and Norway in company with the preceding species, but is not nearly so common, nor is its range of habitat so great; it does not seem to approach nearer to the shore than depths of 15—20 fathoms. In the Glacial clays, however, it is much more abundant, being, perhaps, the commonest of all the Ostracoda in those formations. It may readily be distinguished

from *C. papillosa* by its dull, unpolished surface, distinct punctation, and less conspicuous papillæ, as well as by the anterior elevation of the dorsal margin and the less exerted infero-posteal angle; it is also a considerably smaller species. The young forms of the two sexes are represented at figs. 6 and 7. *C. punctillata* approaches closely Bosquet's "*Bairdia*" (*Cytheridea*) *punctatella*, and *B. Hebertiana*, as also (*fide* Bosquet) to *C. Muelleri*, Münster; but it is not strictly referable to any of these forms. M. Bosquet himself considers it a distinct species.

DISTRIBUTION. *Recent*.—Baffin's Bay, Gulf of St. Lawrence, Spitzbergen, Norway, Britain.

*Fossil*.—Occurring in nearly all the Scottish beds. Ireland: Woodburn and Portrush. England: Bridlington.

3. CYTHERIDEA TOROSA (*Jones*). Plate XV, figs. 11, 12. *Var. TERES*, Plate VII, figs. 1, 2.

1850. CANDONA TOROSA, *Jones*. Ann. Mag. Nat. Hist., ser. ii, vol. vi, p. 27, pl. iii, fig. 6.

1856. CYPRIDEIS —, *Jones*. Monog. Tertiary Entom., p. 21, pl. ii, figs. 1 a—1 i, and Woodcut, fig. 2, p. 16.

1870. CYTHERIDEA TOROSA, *Brady and Robertson*. Ann. Mag. N. H., ser. iv, vol. vi, p. 21, pl. viii, figs. 6, 7.

Carapace of the *female*, as seen from the side, oblong, subelliptical, greatest height in the middle, and equal to rather more than half the length. Extremities rounded, the posterior narrower and rather oblique. Dorsal margin gently and evenly arched, ventral straight or very slightly sinuated in front; at the infero-posteal angle there is often a short thick spine. Outline, as seen from above, oblong ovate, having on each lateral margin several (usually three) equidistant nodular projections with intervening sulci. The right valve is smaller than the left and slopes away much more steeply behind. The shell of the *male* is as usual much narrower, longer, and more angular. Shell very thick and strong, marked with closely set, rounded pittings, and bearing on each valve several (usually four) large, rounded, prominent tubercles. Colour yellowish or greenish-brown.

Length,  $\frac{1}{8}$ th of an inch.

*Var. TERES*. Plate VII, figs. 1, 2.

1864. CYPRIDEIS TOROSA, *Brady*. Trans. Tyneside Nat. Field Club, vol. vi, p. 108, pl. iii, figs. 11—23, and Ann. Mag. N. H., ser. iii, vol. xiii, p. 62, pl. iv, figs. 11—23.

1865. CYPRIDEIS TOROSA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 51.

1868. CYTHERIDEA TOROSA, *Brady*. Monog. Rec. Brit. Ostrac., p. 425, pl. xxviii, figs. 7—12; pl. xxxix, fig. 5.
1868. — LITTORALIS, *Brady*. Nat. Hist. Trans. Northumb. and Durham, vol. iii, p. 125.
1870. — TOROSA, var. TERES, *Brady* and *Robertson*. Ann. and Mag. N. H., ser. 4, vol. vii, p. 21.

This differs from the typical form in being altogether destitute of tubercular prominences, which are replaced in most cases by a shallow transverse median sulcus on the lateral aspect of the valves.

*C. torosa* is usually an inhabitant of brackish water, where it is often found living in immense numbers, the situations which it haunts being chiefly salt marshes and muddy estuaries. It has, however, though very rarely, been found in quite fresh water, and more frequently in shallow littoral situations exposed to purely marine influences; but in neither of these latter cases does it ever occur very abundantly.

We have not ourselves met with the typical tuberculated form of this species amongst Post-tertiary fossils, except in one locality, our examples being otherwise referable to the smooth variety (*teres*, *Brady* and *Robertson*).

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Levant, Sea of Azoff.

*Fossil*.—England: Grays Thurrock. Scotland: Drip Bridge, Raised beach at Oban. South Wales: New Dock basin at Cardiff. Ireland: Portrush.

#### 4. CYTHERIDEA LACUSTRIS (*G. O. Sars*). Plate VI, figs. 16—20.

1863. CYTHERE [LACUSTRIS, *G. O. Sars*. Om en i Sommeren 1862 foretagen zoologisk Reise, p. 30.
1868. CYTHERIDEA — *Brady*. Monog. Rec. Brit. Ostrac., p. 427, pl. xxvi, figs. 18—21; pl. xl, fig. 2.

Carapace of the *female*, as seen from the side, subquadrangular, highest at the anterior third, greatest height equal to considerably more than half the length; anterior extremity broad and well rounded; posterior narrow and not so boldly rounded; superior margin highest over the anterior hinge, thence sloping rather steeply and in a more or less undulating line backwards; inferior margin deeply sinuated in the middle, thence sloping upwards and backwards with a gentle curve. Outline, as seen from above, ovate, the lateral margins subparallel, irregularly sulcate and tuberculate, extremities obtusely pointed, greatest width equal to half the length. End-view broadly and irregularly ovate. Surface of the shell marked with closely set angular pittings, and bearing on the lateral aspect several (2—5) large rounded tubercles. Hinge-processes (fig. 20) not



crenulated, consisting of two not very prominent terminal projections of the right which articulate with corresponding sulci of the left valve. *Male* unknown.

Length,  $\frac{1}{30}$ th of an inch.

*Cytheridea lacustris* is an inhabitant of fresh water. It appears to be of rare occurrence in the living state, having been noticed only in two localities in Scotland and one in England and in some Norwegian lakes. The tubercular eminences of the shell are very variable in number and degree of elevation, sometimes being almost obsolete, and at others forming a very conspicuous feature. The generic position of the species must be looked upon as provisional until the male has been seen and examined in the recent state.

DISTRIBUTION. *Recent*.—Norway, Scotland, England.

*Fossil*.—England: Hornsea, Branston Fen. Scotland: Crofthead, Dipple.

#### 5. CYTHERIDEA SORBYANA, Jones. Plate VII, figs. 7—12.

1856. CYTHERIDEA SORBYANA, Jones. Monog. Tert. Entom., p. 44, pl. iv, figs. 6 a—6 e.  
 1865. — DENTATA, G. O. Sars. Overs. Norg. mar. Ostrac. (right valve), p. 56.  
 1865. — INERMIS, G. O. Sars. Overs. Norg. mar. Ostrac. (left valve), p. 56.  
 1868. — SORBYANA, Brady. Monog. Rec. Brit. Ostrac., p. 428, pl. xxix, figs. 1—6.

Carapace, as seen from the side, broadly subtriangular, greatest height situated in front of the middle and equal to about two thirds of the length; anterior extremity broadly rounded and bearing several (6—8) triangular spines, which point obliquely downwards and forwards; posterior extremity narrow and somewhat exserted below; superior margin much elevated and almost gibbous over the anterior hinge, thence sloping in a continuous and bold curve to the postero-ventral angle; inferior margin almost straight, terminated behind by a single stout pointed spine, which projects obliquely downwards and backwards from the extremity of the right valve. The left valve is higher than the right, the spines on its anterior margin are often almost obsolete, and its posterior angle is rounded off and bears no spine. Outline, as seen from above, broadly oval, greatest width in the middle and equal to more than half the length, mucronate in front. Surface of the shell marked, except toward the centre, with coarse, irregularly sinuous, concentric furrows, and pitted, usually in the interspaces, with numerous minute punctures.

Length,  $\frac{1}{30}$ th of an inch.

We have seen only one perfect specimen of this species, which was found by Mr. Robertson amongst some clay from Norway. Detached valves, however, are not uncommon in some of our British clay beds, and a few examples, also separated valves, have been dredged in Shetland, and off the north-western shores of Scotland, in considerable depths (60 fathoms and upwards) of water.

DISTRIBUTION. *Recent*.—Norway, Scotland, Gulf of St. Lawrence, Spitzbergen.

*Fossil*.—England: Bridlington. Scotland: Elie, Dryleys, Errol, King Edward's, Tangyburn. Norway and Canada: Post-tertiary beds.

6. CYTHERIDEA (?) INORNATA, *n. sp.* Plate VII, figs. 3—6.

Carapace, as seen from the side, oblong, subreniform, highest behind the middle, greatest height equal to more than half the length. Anterior extremity obtusely, posterior boldly and obliquely rounded; superior margin forming a flattened curve, highest at the posterior third, inferior rather deeply sinuated in the middle. Outline as seen from above compressed, ovate, width considerably less than half the length. Surface perfectly smooth.

Length,  $\frac{1}{3}$ rd of an inch.

Except for its occurrence in company with distinctly marine species, we should almost have placed this in the genus *Candona*, to which it bears a very strong resemblance. Some undoubtedly marine forms have, however, been described (*Cytheridea Zetlandica*, Brady, and *C. nobilis*, Brady), which present very similar characters; but in none of these cases have the recent animals been procured in a state fit for anatomical examination. Their present generic position must consequently be looked upon as merely provisional.

DISTRIBUTION, *fossil*.—Scotland: Annochie.

7. CYTHERIDEA ELONGATA, *Brady*. Plate IX, figs. 10—13.

1850. CYTHERE ANGUSTATA, *Baird* (not of Münster). Brit. Entom., p. 172, pl. xxi, fig. 6.

1868. CYTHERIDEA ELONGATA, *Brady*. Monog. Rec. Brit. Ostrac., p. 421, pl. xxviii, figs. 13—16; pl. xl, fig. 6.

Carapace, as seen from the side, elongated, subreniform, higher behind than in front, greatest height situated near the middle and equal to considerably less than half the length; anterior extremity evenly, posterior obliquely rounded; superior margin forming a some-

what flattened arch, inferior distinctly sinuated in front of the middle and slightly protuberant behind. Outline as seen from above elongato-ovate, widest behind the middle, where the width is equal to little more than one third of the length, obtusely pointed in front, posterior extremity rounded and slightly indented in the middle. Hinge-processes feebly developed (fig. 13), consisting of two slightly elevated angular crests on the right, and two slightly crenated sinuations on the left valve. Surface of the shell smooth, ornamented with numerous, small, distantly scattered, circular papillæ, and frequently marked towards the extremities and along the ventral surface with more or less distinct longitudinal furrows.

Length,  $\frac{1}{8}$ th of an inch.

This species, which is of frequent occurrence round the British shores at the present day, seems to occupy, in some of its characters, especially in those of the hinge-joint, a position intermediate between the genera *Cythere* and *Cytheridea*. The animal structure is, however, very distinct from that of the former genus, and, so far as we at present know, does not differ from that observed in *Cytheridea*.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Bay of Biscay, Gulf of St. Lawrence.

*Fossil*.—England: Hopton Cliff. Scotland: Irvine. Ireland: New Docks at Belfast, Portrush.

#### Genus 4—EUCYTHERE, Brady.

Carapace high and compressed in front, lower and more tumid behind. Shell thin, pellucid, and marked with conspicuous round white papillæ. Hinge-joint formed on the left valve by a projecting flange or crest, which is received into a corresponding depression of the left valve. "Superior antennæ five-jointed, and in structure almost like those of *Cythere*; inferior much more robust, four-jointed; flagellum (urticating seta) long. Mandibular palp three-jointed; branchial appendage very small. Cutting portion of the first maxillæ weaker than usual; internal segment rudimentary. Second pair of maxillæ very large, dilated in an extraordinary manner at the apex, flabelliform, and beset with numerous apical setæ. Feet weak and slender, subequal; terminal claws long and almost straight, alike in the male and female. Copulative organs of the male unusually small. One eye."

EUCYTHERE ARGUS (*G. O. Sars*). Plate X, figs. 12—15.

1865. CYTHEROPSIS ARGUS, *Sars*. Overs. Norg. mar. Ostrac., p. 58.

1868. EUCYTHERE — *Brady*. Monog. Rec. Brit. Ostrac., p. 431, pl. xxvii, figs. 49—51.

Carapace of the *female*, as seen from the side, oblong, subreniform, higher in front than behind, greatest height in the middle and slightly exceeding half the length; anterior extremity broadly, posterior narrowly rounded; superior margin boldly arched; inferior sinuated in the middle. Seen from above, ovate, widest behind the middle, greatest width equal to half the length, obtusely pointed in front, rounded behind. Shell-surface smooth and polished, thickly set with large circular white papillæ or tubercles, which are often dotted in the centre. Shell of the *male* more compressed; seen from the side, subcuneiform, superior margin highest in front of the middle, thence sloping steeply and almost in a right line backwards; inferior margin perfectly straight.

Length,  $\frac{1}{45}$ th of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Gulf of St. Lawrence.

*Fossil*.—Scotland: Duntroon, Loch Gilp, Kyles of Bute, Kilchattan, Cumbræ, Dumbarton, Cartsdyke, Paisley, Dalmuir, Old Mains, Elie, Drip Bridge. South Wales: new Dock Basin at Cardiff. Ireland: Portrush. Norway and Canada: Post-tertiary beds.

Genus 5—KRITHE, *Brady, Crosskey, and Robertson*.<sup>1</sup>

Valves thin and pellucid, subovate, truncate behind; smooth and shining, and set with very small distant papillæ. Hinge-joint simple, formed by a slight projection of the left valve, which is received into a corresponding depression of the right. Upper antennæ very stout, five-jointed, the first two joints much thickened, the last three short and bearing long curved spines; lower antennæ four-jointed. Mandibles small, with

<sup>1</sup> κριθή, a barley-corn. The name *Ilyobates* was applied by G. O. Sars in 1865 to this genus; but, as the same term had been used by Kraatz ('Naturgeschichte der Insecten Deutschlands') in 1858 to designate a genus of Coleoptera, it has become necessary to adopt a fresh name.

unusually long slender teeth; palp three-jointed, the second joint elongated, "branchial appendage having two long ciliated setæ and one rudimentary." Maxillæ of the usual form. Feet very short; the first two pairs three-jointed, the last pair four-jointed. "Right foot of the last pair, in the male, prehensile and only three-jointed, terminal claw very large and strong. Abdomen of the female very convex above, the postabdominal lobes bearing two short hairs." Eyes wanting.

1. *KRITHE GLACIALIS*, *nov. sp.* Plate VI, figs. 21—26.

Carapace of the *female*, as seen from the side, subrhomboidal, almost equal in height throughout, height equal to nearly two thirds of the length; anterior extremity evenly rounded; posterior obliquely truncate; superior margin gently arched and forming a rounded obtuse angle posteriorly; inferior convex. Outline, as seen from above, ovate, widest in the middle, acutely pointed in front, rectangularly truncate behind, greatest width slightly exceeding half the length, posterior extremity slightly emarginate at each side of the median line. End-view nearly circular. Carapace of the *male* narrower and longer, dorsal and ventral margins nearly straight, infero-posteal angle more pronounced. Shell-surface smooth, bearing several scattered circular papillæ and a few rather short thick hairs. Lucid spots large, oblong, four in a transverse row a little below and in front of the centre of the valve and one or two a little in advance of the main group.

Length,  $\frac{1}{3\frac{1}{4}}$ th of an inch.

This species differs little from *Krithe Bartonensis*, except in the greater size and wider proportions of the carapace, and in the rectangularly truncate posterior extremity. It has not yet been seen in the recent state.

*Fossil*.—Scotland: Errol. Norway.

2. *KRITHE BARTONENSIS* (*Jones*). Plate II, figs. 22—26.

1856. *CYTHERIDES BARTONENSIS*, *Jones*. Monog. Tert. Entom., p. 50, pl. v, figs. 2 a, 2 b, 3 a, 3 b.

1865. *ILYOBATES PRÆTEXTA*, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 60.

1868. — *BARTONENSIS*, *Brady*. Monog. Rec. Brit. Ostrac., p. 432, pl. xxxiv, figs. 11—14, and pl. xl, fig. 5.

Carapace of the *female*, as seen from the side, oblong, highest near the middle,

height equal to at least half the length; anterior extremity rounded; posterior scarcely rounded, rather oblique, subangular below and sloping steeply above to the dorsal margin; superior margin arcuate; inferior nearly straight, and forming almost a right angle with the hinder extremity. Seen from above, ovate, tapering in front to an obtuse point; posterior extremity narrow and deeply emarginate, greatest width less than half the length. The shell of the *male* is longer and narrower, with an almost flat superior margin. Surface perfectly smooth, whitish, or pellucid brown.

Length,  $\frac{1}{3}\frac{1}{5}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Norway.

*Fossil*.—England: Tertiary, Barton. Scotland: Post-tertiary, Duntroon, Crinan. Norway.

Genus 6—LOXOCONCHA, *G. O. Sars*.

Valves nearly equal, subrhomboidal, and mostly flexuous in outline, evenly convex. Surface smooth or marked with concentrically arranged impressed puncta or with polygonal fossæ, often also with minute circular papillæ. Ventral margin forming a prominent compressed keel behind the middle; postero-superior angle obliquely truncate. Hinge-joint formed by two small teeth at the extremities of the hinge-line of each valve. Limbs of the animal slender and colourless. Upper antennæ very slender, six-jointed, the last joint very long, linear, and bearing long simple setæ; lower antennæ four-jointed, the third joint long and narrow; flagellum long and biarticulate. Mandibular palp three-jointed, bearing a distinct branchial appendage. Lowest seta of the branchial plate of the first pair of jaws deflexed. Feet long and slender, alike in male and female. Abdomen terminated by a hairy conical process; postabdominal lobes bearing two moderately long subequal setæ.

The members of this genus are easily recognised by their obliquely quadrangular or "peach-stone-shaped" outline. They occur in considerable abundance in our seas as well as in the Glacial clays, but the number of species is comparatively small. The females in this genus are very much more common than the males.

1. LOXOCONCHA IMPRESSA (*Baird*). Plate VIII, figs. 1—4.

1850. CYTHERE IMPRESSA, *Baird*. *Brit. Entom.*, p. 173, pl. xxi, fig. 9.

1854. — FLAVIDA, *Zenker*. *Anatomisch.-System: Studien über die Krebsthiere*, p. 86, pl. v B.

1851. CYTHERE RHOMBOIDEA, *Fischer*. Abhandl. Bayerischen Akad. Wissensch., vol. vii, p. 656.
1853. — VIRIDIS, *Lilljeborg*. De Crustaceis ex ordinibus tribus, p. 168, pl. xviii, figs. 4—6; pl. xix, figs. 3—5.
1865. — CABINATA, *Brady*. Ann. Mag. N. H., ser. iii, vol. xvi, p. 190, pl. ix, figs. 1—4.
1865. LOXOCONCHA RHOMBOIDEA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 62.
1868. — IMPRESSA, *Brady*. Monog. Rec. Brit. Ostrac., p. 433, pl. xxv, figs. 35—40; pl. xl, fig. 4.

Carapace of the *female*, as seen from the side, subrhomboidal, flexuous, greatest height near the middle, equal to fully two thirds of the length; extremities obliquely rounded, the posterior somewhat prominent above the middle; superior margin well arched, its posterior angle sinuated and obliquely truncate; inferior convex, distinctly sinuated in front. Outline, as seen from above, ovate, widest in the middle, extremities equally tapering and pointed, greatest width equal to half the length. End-view very broadly ovate, keeled. The shell of the *male* is unlike that of the female, much lower in front than behind, the upper margin straight and abruptly angulated at each extremity (see figure of male, *L. guttata*, Pl. VIII, fig. 7). Surface marked with closely set concentric circular punctures, which on the ventral surface run into somewhat moniliform furrows; in the interspaces are a few distant circular papillæ. The shell is dense in structure, and in old specimens is covered with a thick calcareous crust, which almost obliterates the surface-markings.

Length,  $\frac{1}{8}$ th of an inch.

*L. impressa* is very abundant on most parts of the British coast at the present day, ranging from the littoral zone to depths of about twenty-five fathoms; it occurs also in the more recent Glacial and Post-tertiary formations, but not in those of old date. Its characters are well marked and not likely to be confounded with those of any other fossil species.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Bay of Biscay.

*Fossil*.—Scotland: Duntroon, Crinan, West Tarbert, Raised beaches at Oban and Cumbrae. Ireland: New Docks at Belfast, Portrush. Norway.

## 2. LOXOCONCHA GUTTATA (*Norman*). Plate VIII, figs. 5—7.

1865. CYTHERE GUTTATA, *Norman*. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 19, pl. vi, figs. 9—12.
1868. LOXOCONCHA GUTTATA, *Brady*. Monog. Rec. Brit. Ostrac., p. 436, pl. 27, figs. 40—44.

Carapace of the *female*, as seen from the side, subrhomboidal; greatest height in the middle, equal to more than half the length, rounded obliquely in front, produced behind into an obtuse median projection; superior margin almost straight, inferior sinuated in front, convex behind. Outline, as seen from above, broadly ovate, extremities mucronate. The carapace of the *male* is much more elongated, height equal to half the length; dorsal margin quite straight and angular at its extremities; posterior margin rounded. Surface of the shell marked with large and deep, polygonal, concentrically arranged excavations, which, however, are mostly absent from the margins of the valves.

Length,  $\frac{1}{8}$ rd of an inch.

*L. guttata* occurs in a recent state in our seas, in depths of 10—30 fathoms.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Bay of Biscay, Levant.

*Fossil*.—Scotland: Drip Bridge.

3. LOXOCONCHA MULTIFORA (*Norman*). Plate XIV, figs. 11, 12, *a*, *b*.

1858. ? CYTHERE HASTATA, *Egger*. Ostrak. Miocän-Schicht. Ortenburg, p. 32, pl. ii, fig. 6.

1864. — MULTIFORA, *Norman*. Brit. Assoc. Rep., p. 192; Nat. Hist. Trans. Northumberland and Durham (1865), vol. i, p. 18, pl. vi, figs. 13—16.

1868. CYTHEROPTERON MULTIFORUM, *Brady*. Monog. Rec. Brit. Ostrac., p. 449, pl. xxix, figs. 38—42.

Carapace, as seen from the side, compressed, rhomboidal; height equal to about half the length and nearly equal throughout; extremities oblique and slightly rounded; superior margin straight, slightly sinuated in the middle; inferior almost straight; seen from above, ovate, widest behind the middle; width and height equal; acuminate in front, more obtuse behind. Shell marked over its entire lateral aspect, with large and rather distant angular fossæ, and behind the middle, just within the inferior margin, raised into an irregularly curved alæform ridge.

Length,  $\frac{1}{10}$ th of an inch.

The almost obsolete alæform projection of the shell induced the author of the 'Monograph of the Recent British Ostracoda' to place this species in the genus *Cytheropteron*. We have, however, since that period become acquainted with some even more distinctly alate forms which undoubtedly belong to *Loxoconcha*, and, as the present species is in general appearance quite in accord with that genus, we have no hesitation in removing it from its former position.

DISTRIBUTION. *Recent*.—Great Britain.

*Fossil*.—Ireland: Portrush.



4. *LOXOCONCHA TAMARINDUS* (Jones). Plate VIII, figs. 8—11.

1866. *CYTHEREIDEIS TAMARINDUS*, Jones. Monog. Entom. Tert. Form. England, p. 49, pl. iii, figs. 4 a, 4 b.  
 1865. *CYTHERE LEVATA*, Norman. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 18, pl. v, figs. 13—16.  
 1865. *LOXOCONCHA LONGIPES*, G. O. Sars. Overs. Norg. mar. Ostrac., p. 63.  
 1868. — *TAMARINDUS*, Brady. Monog. Rec. Brit. Ostrac., p. 435, pl. xxv, figs. 45—48.

Carapace of the *female*, as seen from the side, elongate, subrhomboidal, height nearly equal throughout, and equal to about half the length. Extremities obliquely rounded; superior margin nearly straight, obtusely angular behind; inferior slightly sinuated in front, then convex. Outline, as seen from above, elongate-ovate, its greatest width in the middle, and equal to less than half the length. End-view broadly ovate, keeled. Shell of the *male* narrower and more elongated (fig. 11). Surface of the valves smooth, minutely and closely punctate and bearing a few very small scattered papillæ.

Length,  $\frac{1}{50}$ th of an inch.

This species is found abundantly in the living state in the British Seas and on the coast of Norway, ranging from 2 to 40 fathoms.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Bay of Biscay.

*Fossil*.—Scotland: in nearly all the Post-tertiary beds on the west, and on the east at Elie and Drip Bridge. Ireland: New Docks at Belfast, Portrush. England: Crag, Suffolk. Norway; Post-tertiary.

5. *LOXOCONCHA ELLIPTICA*, Brady. Plate XIV, figs. 23—25.

- LOXOCONCHA ELLIPTICA*, Brady. Monog. Rec. Brit. Ostrac., p. 435, pl. xxvii, figs. 38, 39, 45—48; pl. xl, fig. 3.

Carapace of the *male*, oblong, compressed; seen from the side, subrhomboidal, nearly equal in height throughout; height equal to somewhat more than half the length; anterior extremity obliquely, posterior well and evenly rounded; superior margin straight, inferior slightly sinuated in the middle; seen from above, compressed, ovate, pointed in front, narrowly rounded or submucronate behind, width equalling nearly half the length. The shell of the *female* is shorter, more tumid, and has the dorsal margin distinctly arched. Surface of the valves smooth, bearing several small scattered circular papillæ.

Length (of the male),  $\frac{1}{40}$ th of an inch.

This very well-marked species is a characteristic inhabitant of brackish water, being seldom or never found living in purely marine situations. In the water of salt marshes, estuaries, and at the heads of contracted bays where there is much influx of fresh water, it often occurs in great abundance, and in such situations it appears to be generally distributed round the coasts of Europe.

**DISTRIBUTION.** *Recent.*—Great Britain and Europe.

*Fossil.*—Scotland: Govan. South Wales: New Dock-basin at Cardiff.

6. *LOXOCONCHA FRAGILIS*, G. O. Sars. Plate XIV, figs. 30—32.

*LOXOCONCHA FRAGILIS*, G. O. Sars. Overs. Norg. mar. Ostrac., p. 65.

Carapace of the *male* oblong, subrhomboidal, somewhat higher behind than in front, surrounded, except on the superior margin, by a broad laminar fillet, which is most developed behind and on the posterior portion of the ventral margin; height fully equal to half the length; anterior extremity well rounded, posterior rather broader, oblique and produced above the middle into a short obtusely rounded beak; superior margin straight, inferior sinuated in the middle, seen from above, ovate, with pointed extremities. Shell smooth, fragile, bearing usually a few scattered circular papillæ, the marginal belt marked with radiating hairlike lines. Carapace of the *female*, differing from that of the male in the same way as in the foregoing species.

Length,  $\frac{1}{80}$ th of an inch.

**DISTRIBUTION.** *Recent.*—Great Britain and Norway.

*Fossil.*—Scotland: Cartsdyke, Paisley.

Genus 7—*XESTOLEBERIS*, G. O. Sars.

Shell very smooth and polished, ornamented with small round distant papillæ, much lower in front than behind; in the *female* very tumid behind. Hinge-joint formed by a dentated projecting crest of the left, which is received into an excavation of the right valve. Ventral margin of both valves incurved in front of the middle. Upper antennæ six-jointed, the last four joints successively decreasing in length, and bearing very short simple setæ; lower antennæ short, four-jointed, flagellum of moderate length. Mandibular palp four-jointed, "branchial appendage small and bearing

This genus is chiefly distinguished by the peculiar form of the carapace, which is very low and pointed in front, elevated and tumid behind, in these respects offering a direct contrast to the genus *Eucythere*, with which, however, in the character of the hinge-joint and of the surface-markings, it to a great extent agrees.

1865. XESTOLEBERIS DEPRESSA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 68.  
 1868. — — *Brady*. Monog. Rec. Brit. Ostrac., p. 438, pl. xxvii,  
 figs. 27—33.  
 1850. ? CYTHERINA TUMIDA, *Reuss*. Foss. Entom. Oesterr. Tert. Beckens, p. 57,  
 pl. viii, fig. 29.  
 1858. ? CYTHERIDEA TUMIDA, *Egger*. Ostrak. Miocän-Schicht. Ortenburg, p. 17,  
 pl. ii, fig. 11.

Length,  $\frac{1}{45}$ th of an inch.

**DISTRIBUTION.** *Recent*.—Great Britain, Ireland, Norway, Spitzbergen, Gulf of St. Lawrence.

*Fossil*.—Scotland: Loch Gilp, Paisley, Wick, West Tarbert, Raised beach at Oban.  
Ireland: New Docks at Belfast. Norway and Canada.

2. XESTOLEBERIS AURANTIA (*Baird*). Plate XVI, figs. 32, 33.

1835. CYTHERE AURANTIA, *Baird*. Mag. Zool. Bot., ii, 143, pl. v, fig. 26; and  
(1850) Brit. Entom., p. 171, pl. xxi, fig. 8.  
1853. — NITIDA, *Lilljeborg*. De Crustaceis, p. 169, pl. xix, figs. 6, 7.  
1854. — VIRIDIS, *Zenker*. Anat. Syst. Studien über die Krebst., p. 86, pl. v A.  
1865. XESTOLEBERIS NITIDA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 67.  
1868. — AURANTIA, *Brady*. Monog. Brit. Ostrac., p. 437, pl. xxvii,  
figs. 34—37; pl. xxxix, fig. 6.

Shell of the *female*, seen from the side, subtriangular, greatest height situated behind the middle and equal to nearly two thirds of the length. Anterior extremity much narrowed, rounded, posterior very broadly rounded; superior strongly arched, inferior very slightly sinuated in front of the middle. Seen from above, ovate, acuminate in front, broadly rounded behind, greatest width behind the middle, and equal to half the length. The shell of the *male* is more elongated, and scarcely so tumid behind. Shell smooth and ornamented with minute and distant circula papillæ; there is usually (even in fossil specimens) a dark-coloured spot on each valve near the position of the eyes.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Holland, Great Britain, Ireland.

*Fossil*.—Scotland: Raised beach at Cumbrae. South Wales: New Dock-basin at Cardiff. Ireland: New Docks at Belfast. Norway.

Genus 8—CYTHERURA, *G. O. Sars*.

Valves unequal and dissimilar in form, the right more or less overlapping the left on the dorsal margin; surface reticulated, punctated, deeply excavated, or bearing irregularly disposed ribs or protuberances, mostly marked with a central areola of darker colour than the rest of the shell. Carapace oblong or subtriangular, the posterior extremity produced into a more or less prominent beak. Hinge-processes mostly obsolete. Superior antennæ shortly setose, six-jointed, gradually tapering; second joint bearing a rather long seta on the middle of the posterior margin; inferior antennæ five-jointed, terminal claws short; flagellum long, triarticulate. Mandibles robust, with very blunt teeth, "palp three-jointed, branchial appendage small, and bearing only two recurved setæ." Terminal

lobes of the first pair of maxillæ long and narrow, "branchial plate bearing on its external margin two non-ciliated setæ, which are directed downwards, and arise from a separate lobe." Feet small, the terminal claws short and curved. Eyes distinct. Copulative organs of the male very complex, provided with several irregular processes and a very long spirally convoluted tube.

The species belonging to this genus are the smallest of the *Cytheridæ*; they occur in considerable numbers, and various species are so closely related one to the other that it is often by no means easy to identify them with certainty. The species we have now to describe are to a large extent identical with those now living in the British seas.

1. *CYTHERURA NIGRESCENS* (*Baird*). Plate XI, figs. 28—32; and Plate XII, fig. 13.

- |       |                             |                |  |
|-------|-----------------------------|----------------|--|
| 1838. | <i>CYTHERE NIGRESCENS</i> , | <i>Baird</i> . | <i>Mag. Zool. Bot.</i> , vol. ii, p. 143, pl. v, fig. 27.  |
| 1850. | —                           | —              | <i>Baird</i> . <i>Brit. Entom.</i> , p. 171, pl. xxi, figs. 4, 4 a.                                  |
| 1865. | <i>CYTHERURA</i>            | —              | <i>G. O. Sars</i> . <i>Overs. Norg. mar. Ostrac.</i> , p. 71.  |
| 1868  | —                           | —              | <i>Brady</i> . <i>Monog. Rec. Brit. Ostrac.</i> , p. 440, pl. xxxii, figs. 50—55; pl. xxxix, fig. 7. |

Carapace of *female*, as seen from the side, subrhomboidal, highest in the middle, greatest height equal to quite half the length; anterior extremity rounded, posterior produced above the middle into a short obtuse beak; superior margin evenly and boldly arched, inferior slightly sinuated. Outline, as seen from above, compressed, ovate, pointed at each extremity, widest in the middle, width equal to rather more than one third of the length. End-view broadly ovate. Surface of the shell smooth, often slightly punctate.

Length,  $\frac{1}{8}$ nd of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland.

*Fossil*.—England: Hopton Cliff. Scotland: nearly all the Post-tertiary beds on the west, and at Drip Bridge. Ireland: New Dock at Belfast, Portrush. Norway and Canada.

2. *CYTHERURA SIMILIS*, *G. O. Sars*. Plate XI, figs. 16—18; Plate XII, fig. 16.

- |       |                            |                     |   |
|-------|----------------------------|---------------------|---|
| 1865. | <i>CYTHERURA SIMILIS</i> , | <i>G. O. Sars</i> . | <i>Overs. Norg. mar. Ostrac.</i> , p. 72.   |
| 1868. | —                          | —                   | <i>Brady</i> . <i>Monog. Rec. Brit. Ostrac.</i> , p. 442, pl. xxxii, figs. 56—59. |

Carapace, as seen from the side, subovate, highest in the middle, greatest height equal to rather more than half the length; anterior extremity rounded, posterior produced in the middle, but scarcely beaked; superior margin boldly and evenly arched, inferior nearly

straight. Outline, seen from above, ovate, widest in the middle, width equalling half the length. End-view ovate, tumid, widest towards the base, width and height equal. Shell smooth, obscurely reticulated. Very similar to the preceding, but larger, more ventricose, and less distinctly beaked posteriorly.

Length,  $\frac{1}{8}$ rd of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Holland, Spitzbergen.

*Fossil*.—Scotland: Duntroon, Loch Gilp, Kyles of Bute, Kilohattan, Cumbræ, Dumbarton, Cartdyke, Dalmuir, Barrie. Ireland: New Docks at Belfast, Portrush. Norway.

### 3. CYTHERURA FLAVESCENS, *Brady*. Plate XVI, figs. 7, 8.

1869. CYTHERURA FLAVESCENS, *Brady*. *Ann. Mag. N. H.*, ser. 4, vol. iii, p. 49, pl. viii, figs. 13—15.

Carapace, seen from the side, subquadrangular, nearly equal in height throughout, height equal to half the length; anterior extremity imperfectly rounded and somewhat oblique; posterior produced in the middle into a broad rounded beak; superior margin flattened, slightly sinuated in the middle; inferior with a distinct median sinuation. Seen from above, ovate, widest near the middle, subacuminate in front, mucronate behind, width rather less than the height. Surface of the shell marked longitudinally with numerous flexuous, anastomosing, but not very prominent, ribs.

Length,  $\frac{1}{8}$ nd of an inch.

DISTRIBUTION. *Recent*.—Britain, Holland.

*Fossil*.—Scotland: Kyles of Bute.

### 4. CYTHERURA PUMILA, *nov. sp.* Plate XI, figs. 33—35.

Carapace of the *female*, seen from the side, subovate, highest in the middle, height equal to more than half the length; rounded in front, produced in the middle behind, but not beaked; superior margin arched; inferior nearly straight. Outline, seen from above, compressed, ovate, widest near the middle, nearly thrice as long as broad, extremities pointed. Shell of the *male* (fig. 35) long and narrow. Surface of the valves obscurely undulated and finely punctate.

Length,  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Recent*.—Shetland. Gulf of St. Lawrence.

*Fossil*.—Scotland: Duntroon, Cartdyke, Dalmuir.

5. *CYTHERURA CONCENTRICA*, *nov. sp.* Plate XI, figs. 7, 8; Plate XV, fig. 21.

Carapace somewhat peach-stone-shaped, highest in the middle, height equal to half the length; anterior extremity obliquely rounded; posterior oblique, produced in the middle into a short, obtuse beak; superior margin boldly arched; inferior slightly sinuated in front of the middle. Seen from above, compressed, acuminate in front, sharply and strongly mucronate behind; width less than half the length. Shell-surface concentrically striated and finely punctate.

Length,  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Recent.*—Shetland, Gulf of St. Lawrence.

*Fossil.*—Scotland: Paisley, Barrie, Elie, Dryleys, Errol.

6. *CYTHERURA* (?) *COMPLANATA*, *nov. sp.* Plate XI, figs. 19, 20.

Carapace reniform, highest in the middle, height equal to more than half the length; extremities rounded; superior margin boldly and evenly arched; inferior sinuated in the middle. Seen from above, compressed, oblong, with parallel sides. Surface of the valves slightly punctate, marked with a strong elevated ridge round the greater part of the circumference, and with a few shallow rounded pits or areolæ on the posterior portion of the valves.

Length,  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Fossil.*—Scotland: Annochie. Ireland: Woodburn.

7. *CYTHERURA UNDATA*, *G. O. Sars.* Plate XI, figs. 9—15; and Plate XII, fig. 17.

1865. *CYTHERURA UNDATA*, *Sars.* Overs. Norg. mar. Ostrac., p. 75.

1868. — — *Brady.* Monog. Rec. Brit. Ostrac., p. 443, pl. xxxii, figs. 43—49, 66.

Carapace of *female* subrhomboidal, greatest height in the middle and equal to rather more than half the length; anterior extremity obscurely rounded; posterior obliquely subtruncate, somewhat angulated above the middle; superior margin forming a flattened arch; inferior nearly straight. Outline, as seen from above, elongated, subpentagonal, with nearly parallel sides, width considerably less than the height, pointed in front, truncate and centrally mucronate behind. Surface of the shell marked with two longitudinal and three or more irregularly curved transverse ribs, the intervals between

which are sometimes angularly areolated. Shell of the *male* more compressed and more angular in outline.

Length,  $\frac{1}{8}$ nd of an inch.

There is much diversity in the development of the surface-ornament in this species, some specimens showing scarcely more than a mere undulation of the surface (fig. 12), while others (fig. 9) are very distinctly ridged and occasionally even areolated in the interspaces. It is, perhaps, next to *C. nigrescens*, the commonest fossil species of the genus.

DISTRIBUTION. *Recent*.—Baffin's Bay, Gulf of St. Lawrence, Spitzbergen, Norway, Great Britain, Ireland.

*Fossil*.—Scotland: nearly all the Post-tertiary beds. Ireland: New Docks at Belfast, Portrush. Norway. Canada.

8. CYTHERURA COMPRESSA, *nov. sp.* Plate XI, figs. 21—23.

Carapace subrhomboidal, higher in front than behind, greatest height more than equal to half the length, situated in front of the middle; anterior extremity obliquely rounded; posterior angularly produced in the middle; superior margin arched; inferior almost straight. Seen from above, subpentagonal, acuminate in front, mucronate behind, width less than the height. End-view pentagonal, widest in the middle, the base concave, with a central keel. Surface of the shell obsoletely striated.

Length,  $\frac{1}{5}$ th of an inch.

DISTRIBUTION. *Fossil*.—Scotland: Gamrie.

9. CYTHERURA STRIATA, *G. O. Sars.* Plate XI, figs. 38—41.

1865. CYTHERURA STRIATA, *G. O. Sars.* Overs. Norg. mar. Ostrac., p. 74.

1868. — — *Brady.* Monog. Rec. Brit. Ostrac., p. 441, pl. xxxii, figs. 26—29, 62, 64, 65.

Carapace, as seen from the side, compressed, oblong, of nearly equal height throughout, height equal to less than half the length; anterior extremity rounded, posterior produced in the middle into a long beak; superior margin forming a flattened arch, inferior sinuated in the middle. Seen from above, the outline is subpentagonal, with parallel sides, pointed in front and strongly mucronate behind, width about equal to the height. End-view subtriangular, widest at the base, which is centrally keeled. Surface marked with



distinct longitudinal grooves, each of which is mostly impressed with a single series of round punctures.

Length,  $\frac{1}{8}$ th of an inch.

*C. striata* also is very variable in the amount of its shell-sculpture.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland.

*Fossil*.—Scotland: Loch Gilp, West Tarbert, Kyles of Bute, Cumbræ, Carlsdyke, West Tarbert. South Wales: New Dock basin at Cardiff. Ireland: New Docks at Belfast. Norway and Canada.

10. *CYTHURURA QUADRATA*, *Norman*. Plate XIII, figs. 34, 35.

1868. *CYTHURURA QUADRATA*, *Norman*. Last Report on Dredging amongst the Shetland Islands, p. 292.

Shell, seen from the side, subquadrangular, of nearly equal height throughout, height equal to half the length, rounded in front, produced behind into a sharp median beak; superior margin forming a flattened arch; inferior almost straight; seen from above, the greatest width is situated rather in front of the middle, the outline being subhexagonal. The surface-sculpture is very similar to that of *C. striata*, consisting of flexuous longitudinal striæ, the hollows of which are marked with more or less circular pittings; just within the ventral margin is a ridge, terminating in front in a small angular alæform projection.

Length,  $\frac{1}{8}$ th of an inch.

This species differs from *C. striata* in its greater proportionate height and width, and in having its greatest width, when viewed from above, situated towards the anterior extremity, a peculiarity which it shares, so far as we know, only with *C. affinis*. We have seen only a very few detached valves.

DISTRIBUTION. *Recent*.—Shetland, South Wales.

*Fossil*.—South Wales: Cardiff New Dock basin. Ireland: Belfast New Docks.

11. *CYTHURURA CUNEATA*, *Brady*. Plate XIII, figs. 36, 37; Plate XI, figs. 42 and 47.

1868. *CYTHURURA CUNEATA*, *Brady*. Monog. Rec. Brit. Ostrac., p. 442, pl. xxxii, figs. 35—38, 63.

Carapace of *female*, seen from the side, elongated, subquadrangular, nearly equal in height throughout, height scarcely equal to one half the length; rounded in front, pro-

duced behind into a short and obtuse, obliquely truncate, median beak; superior margin nearly straight; inferior slightly sinuated; seen from above, cuneate, greatest width about equal to the height, and situated near the posterior extremity; acuminate in front, mucronate behind. Shell longitudinally striated and marked, more particularly over the protruberant posterior portion, with a delicately reticulated and punctate pattern; within the ventral margin on the posterior half of the valve is a sinuous ridge, which terminates behind in an obtusely rounded alæform projection. The *male* is rather longer and narrower than the female.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Levant.

*Fossil*.—Scotland: West Tarbert.

12. CYTHERURA SARSII, *Brady*. Plate XI, figs. 24—27; Plate XIII, figs. 18, 19.

1868. CYTHERURA SARSII, *Brady*. Monog. Rec. Brit. Ostrac., p. 442, pl. xxxii, figs. 39—42.

Carapace, seen from the side, oblong, subquadrangular, nearly equal in height throughout, height scarcely equalling half the length; anterior extremity rounded; posterior scarcely produced in the middle; superior margin nearly straight; inferior sinuated in the middle; outline, seen from above, compressed, ovate, widest behind the middle, width considerably less than the height, pointed in front, mucronate behind. End-view broadly ovate, widest in the middle. Surface of the shell smooth or obscurely striated and punctate.

Length,  $\frac{1}{8}$ nd of an inch.

DISTRIBUTION. *Recent*.—Scotland.

*Fossil*.—Scotland: Duntroon, Loch Gilp, Kyles of Bute, Cumbræ, Cartadyke, Paisley, Dalmuir, Barrie. Canada.

13. CYTHERURA ANGULATA, *Brady*. Plate XI, figs. 48—51; Plate XII, fig. 14.

1868. CYTHERURA ANGULATA, *Brady*. Monog. Rec. Brit. Ostrac., p. 440, pl. xxxii, figs. 22—25.

Carapace, as seen from the side, compressed, oblong, greatest height near the middle and equal to about one half of the length; anterior extremity rounded; posterior almost rectangular below, and produced above the middle into a large and prominent beak;

Length,  $\frac{1}{8}$ th of an inch.

*Fossil*.—Scotland: Raised beach at Oban. South Wales: Cardiff New Dock-basin. Ireland: Belfast New Docks, Portrush. Norway.

1868. *CYTHERUEA PRODUCTA*, *Brady*. Monog. Rec. Brit. Ostrac., p. 443, pl. xxxii, figs. 60, 61.

Length,  $\frac{1}{80}$ th of an inch.

**Fossil.**—South Wales: Cardiff New Dock-basin.

1785. CYTHERE GIBBA, *Muller*. Entomostraca, p. 24, pl. vii, figs. 10—12.  
 — GIBBERA, *idem*. *ibidem* (*Mas*); Lilljeborg, De Crustaceis, (1853),  
 p. 167, pl. xix, figs. 1, 2.  
 1854. — GIBBA, *Zenker*. Anat. Studien über die Krebsth., p. 84, pl. v, d.  
 1865. CYTHERURA GIBBA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 70.  
 1868. — — *Brady*. Monog. Rec. Brit. Ostr., p. 444, pl. xxxii, figs.  
 68—70.

Carapace of the *female*, as seen from the side, elongated, subquadrangular, of nearly equal height throughout, height equal to about half the length, rounded in front; posterior margin produced above the middle into an obtuse obliquely truncate beak; superior margin almost straight; inferior gently sinuated. Outline, as seen from above, constricted in the middle, the posterior half forming on each side a rounded protuberance, greatest width situated near the posterior extremity and equal to at least half the length; anterior extremity suddenly tapering, acuminate; posterior broadly rounded, with a prominent central mucro. End-view pentagonal, width greater than the height. The *male* more elongated, with the upper margin slightly, the lower deeply, sinuated. The shell is marked, more or less distinctly, with large polygonal reticulations; ventral surface longitudinally striated.

Length,  $\frac{1}{4}$ th of an inch.

DISTRIBUTION. *Recent*.—Britain, Baltic Sea, North Sea.

*Fossil*.—Scotland: West Tarbert, Raised beach at Oban. Ireland: Belfast New Docks, Portrush.

16. CYTHERURA CORNUTA, *Brady*. Plate XIII, figs. 23—25.

1868. CYTHERURA CORNUTA, *Brady*. Monog. Rec. Brit. Ostrac., p. 445, pl. xxxii, figs. 12—15.

This species differs from the foregoing (*C. gibba*) chiefly in having an arcuate dorsal margin, a sharper posterior beak, and when viewed from above in being less tumid posteriorly and without any central constriction. The end-view is triangular instead of pentagonal. The shell-sculpture is much the same in both species. It must be admitted, however, that it is not always easy to determine to which of the two forms a given specimen should be referred.

DISTRIBUTION. *Recent*.—Britain, Dardanelles, Levant.

*Fossil*.—Scotland: West Tarbert Silt. Norway.

17. CYTHERURA ACUTICOSTATA, *G. O. Sars*. Plate XVI, figs. 1—3.

1865. CYTHERURA ACUTICOSTATA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 76.

1868. — — *Brady*. Mon. Rec. Brit. Ostr., p. 445, pl. xxxii, figs. 1—11.

Carapace, as seen from the side, quadrate, subrectangular, height equal to half the

length and nearly uniform throughout; anterior extremity moderately and evenly rounded; posterior produced above the middle into a long and narrow beak; superior margin straight or very slightly sinuated, curved downwards towards the posterior extremity; inferior straight in front, but behind the middle forming a convex curve, which terminates in an acute angle behind. Seen from above, broadly ovate, greatest width situate in the middle and equal to considerably more than half the length; anterior extremity rounded and minutely mucronate; posterior subtruncate, strongly mucronate in the middle. End-view triangular, with irregularly emarginate sides and broadly rounded angles. Surface of the shell sculptured with very prominent and sharply cut flexuous longitudinal ribs.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION *Recent*.—Norway, Great Britain, Ireland. Holland.

*Fossil*.—Scotland: Raised beach at Oban. Ireland: Belfast New Docks. Norway.

18. CYTHERURA CELLULOSA (*Norman*). Plate XI, figs. 5, 6.

1865. CYTHERE CELLULOSA, *Norman*. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 22, pl. v, figs. 17–20; pl. vi, fig. 17.

1865. CYTHERURA NANA, *Sars*. Overs. Norg. mar. Ostrac., p. 78.

1868. — CELLULOSA, *Brady*. Monog. Rec. Brit. Ostrac., p. 446, pl. xxix, figs. 47–50, 60.

Carapace of the *female*, as seen from the side, almost semicircular, except that the postero-inferior angle is obliquely truncate, greatest height in the middle, equal to about two thirds of the length; anterior extremity rounded; posterior obliquely truncate below the middle, where it is produced into a broadly rounded beak; superior margin boldly arched; inferior nearly straight, sinuated in the middle. Seen from above, the outline is lozenge-shaped, compressed, with broadly pointed extremities and nearly parallel sides, width much less than the height. The shell of the *male* (figs. 5, 6) is obliquely ovate, much more elongated and less strongly arcuate on the dorsal margin, the infero-posteal angle rounded off. Surface of the shell marked with very large, irregularly angular pits, in the centre of each of which is a small elevated tubercle.

Length,  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Holland.

*Fossil*.—Scotland: Gamrie, Duntroon, West Tarbert, Raised-beach at Oban. South Wales: Cardiff New Dock basin. Ireland: Woodburn, Raised-beach at Portrush. Norway.

19. CYTHERURA CLATHRATA, *G. O. Sars.* Plate XI, figs. 1—4.1865. CYTHERURA CLATHRATA, *G. O. Sars.* Overs. Norg. mar. Ostrac., p. 77.1868. — — — *Brady.* Monog. Rec. Brit. Ostrac., p. 446, pl. xxix,  
figs. 43—46.

Carapace, as seen from the side, triangular, highest in the middle, greatest height almost equal to three fourths of the length; anterior extremity narrowed, subangular, divided into three or four short, broad teeth; posterior also narrow, produced into an almost obsolete rounded beak; superior margin much elevated in the middle, sloping very steeply and with a scarcely perceptible curve to each extremity, inferior distinctly convex, more or less sinuous. Outline, seen from above, ovate, widest in the middle, greatest width equal to more than half the length, extremities mucronate. End-view triangular, with arcuate sides and flattened base; height much greater than the width. Each valve is traversed by one conspicuous central longitudinal rib, from which several other more or less distinct curved ridges diverge laterally, the interspaces excavated into numerous large fossæ; ventral surface longitudinally striated.

Length,  $\frac{1}{4}$ th of an inch.

This is the largest of the genus, and in general appearance bears considerable resemblance to the preceding species. In the Post-tertiary formations it is apparently of much more frequent occurrence than *C. cellulosa*, though comparatively rare in our seas at the present day.

DISTRIBUTION. *Recent.*—Baffin's Bay, Norway, Great Britain, Ireland.

*Fossil.*—Scotland: Tangyburn, Duntroon, Crinan, Loch Gilp, Blackburn, Cumbræ, Dumbarton, Cartsdyke, Paisley, Dalmuir, Old Mains, Inch Lonaig, Drip Bridge. Ireland: Portrush. England: Bridlington. Norway.

Genus 9—CYTHEROPTERON, *G. O. Sars.*

Valves mostly subrhomboidal, tumid, unequal, and different in shape, the right valve more or less overlapping the left on the dorsal margin; surface of the shell variously sculptured, punctate, papillose, reticulated, or transversely rugose, ventral surface produced laterally into a prominent rounded or spinous ala; posterior margin produced into a more or less distinct but obtuse beak. Hinge formed by two small terminal teeth on the right and by a minutely crenated median bar on

the left valve. Lucid spots usually four, linear oblong, arranged in an obliquely transverse row just above the middle of the ventral margin. Upper antennæ shortly setose and composed of five joints, penultimate joint elongated and bearing on the middle of the anterior margin two hairs; lower antennæ distinctly five-jointed, flagellum long. Mandibles of moderate size; palp three-jointed, branchial appendage bearing two very small setæ. Jaws as in the preceding genus. Feet long and slender, terminal claw slender. Abdomen ending in a long, narrow process, post-abdominal lobes bearing three short hairs. Copulative organs of the male armed behind with three spiniform processes, one of which is trifurcate. Eyes wanting.

1. *CYTHEROPTERON LATISSIMUM* (Norman). Plate VIII, figs. 19—23.

1865. *CYTHERE LATISSIMA*, Norman. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 19, pl. vi, figs. 5—8. Brady, Trans. Zool. Soc., 1866, vol. v, p. 381, pl. lxii, figs. 4 a—e.

1865. *CYTHEROPTERON CONVEXUM*, G. O. Sars. Overs. Norg. mar. Ostrac., p. 80.

1868. *CYTHEROPTERON LATISSIMUM*, Brady. Monog. Rec. Brit. Ostrac., p. 448, pl. xxxiv, figs. 26—30.

Carapace of the *female*, seen from the side, subrhomboidal, highest in the middle, greatest height equal to two thirds of the length. Anterior margin broadly rounded, posterior produced into a short obtusely rounded median beak; dorsal margin boldly arched, sloping steeply behind, more gently and with a slight sinuation in front; ventral somewhat convex, sinuated in front; alæform protuberance rounded off in front, obtusely angular behind. Outline, as seen from above, subovate; greatest width situated behind the middle and equal to two thirds of the length; extremities acuminate. End-view equilaterally triangular, the sides all convex. Shell of the *male* somewhat more elongated, the posterior beak obsolete. Surface marked with more or less distinct, subquadrangular pits arranged transversely, and often coalescing, so as to form well-marked sulci; ventral surface longitudinally furrowed.

Length,  $\frac{1}{3}$ rd of an inch.

There is much variety in the surface-marking of this species, some specimens being distinctly reticulated while others are obscurely rugose, owing to the coalescence of the fossæ; in others, again, as in fig. 23, the transverse furrows become exceedingly deep and well marked. It may be distinguished from *C. nodosum* (with which alone, amongst fossil species, it is likely to be confounded) by the less angular outline, and the absence of any conspicuous tubercles on the dorsal aspect. In the living state *C. latissimum* is met with abundantly round the shores of Britain and Norway, in a depth of 10—60 fathoms,

and has also been found in dredgings from Spitzbergen and Baffin's Bay. G. O. Sars notices its occurrence in a fossil state in the Glacial formations of Norway.

*DISTRIBUTION. Recent.*—Baffin's Bay, Norway, Great Britain, Ireland, Spitzbergen.

*Fossil.*—Scotland: in nearly all the Post-tertiary beds. England: Bridlington. Norway and Canada.

2. CYTHEROPTERON NODOSUM, *Brady*. Plate VIII, figs. 12—15.

CYTHEROPTERON NODOSUM, *Brady*. Monog. Rec. Brit. Ostrac., p. 448,  
pl. xxxiv, figs. 31—34.

Carapace of the *female* (?), seen from the side, subtriangular or subrhomboidal; greatest height in the middle, equal to two thirds of the length. Anterior margin obtusely rounded: posterior obliquely subtruncate; dorsal margin boldly arched, sloping steeply before and behind; ventral nearly straight: edge of the alæform process crested and sharp. Outline, seen from above, ovate, widest in the middle, extremities pointed, width equal to more than half the length; end-view trapezoidal; height greater than the width, angles acute. Surface less distinctly furrowed than in the preceding species, but having two large, rounded tubercles below the dorsal margin, from each of which there runs a more or less distinct elevated rib towards the ventral margin.

Length,  $\frac{1}{4}$ th of an inch.

*DISTRIBUTION. Recent.*—Britain, Ireland, Gulf of St. Lawrence.

*Fossil.*—Scotland: Lag Arran, Duntroon, Crinan, Kyles of Bute, Cumbrae, Cartdyke, Dalmuir, Old Mains, Errol, Drip Bridge. England: Bridlington, Hopton Cliff. Ireland: Woodburn, Portrush. Canada and Norway.

3. CYTHEROPTERON ARCUATUM, *nov. sp.* Plate VIII, figs. 16—18; and Plate XIV, figs. 19—22.

1868. CYTHEROPTERON VESPERTILIO, *Brady*. Ann. Mag. N. H., ser. iv, vol. ii,  
p. 33, pl. v, figs. 6, 7.

Carapace, seen from the side, subsemicircular, highest in the middle; height equal to nearly three fourths of the length; anterior extremity rounded; posterior produced in the middle, but in most cases scarcely beaked; superior margin very boldly and evenly arched; inferior very slightly sinuated in the middle, bending upwards behind. Outline,



as seen from above, subsagittate, widest behind the middle, width equal to nearly two thirds of the length; anterior extremity pointed, lateral margins sloping in a curved line outwards to near the posterior third, where they sink suddenly, forming a rectangular projection, the hinder third of the shell constituting a large triangular process. End-view triangular, the angles all acute. Surface of the shell smooth, bearing more or less numerous scattered circular papillæ, and usually with indistinct transverse striato-reticulate sculpture; the lateral alæ prominent, rounded off gradually in front, rectangular behind, and in old specimens bearing at the angle a strong, awl-shaped mucro or spine.

Length,  $\frac{1}{10}$ th of an inch.

At one time we supposed this interesting species to be identical with the *Cypridina vespertilio* of Reuss and of Egger, but further acquaintance with it and other allied forms convinces us that we were mistaken in that supposition, and that the *C. vespertilio* of those authors is really referable to an immature stage of *Cytheropteron alatum*, G. O. Sars.<sup>1</sup> Young specimens of *C. arcuatum* have the lateral alæ, as a rule, well rounded, and are destitute of the angular spine; the shell is also more fully papillated, but the reticulated surface-ornament, on the contrary, seems to become more distinct with age. *C. hamatum*, of G. O. Sars, is very nearly allied to the present species, but that author himself, from actual examination, considers it to be distinct, an opinion in which we entirely agree with him. The difference is chiefly that of outline, *C. arcuatum* being more boldly arched, and with blunter, wider, and less produced extremities; in these particulars (though in no others) *C. hamatum* more resembles the *C. inflatum* of the present Monograph.

DISTRIBUTION. *Recent*.—Baffin's Bay.

*Fossil*.—Scotland: Tangyburn, Elie, Dryleys, Errol. Ireland: Woodburn.

4. CYTHEROPTERON INFLATUM, *nov. sp.* Plate VIII, figs. 24—27; Plate XIV, figs. 26—29.

1868. CYTHEROPTERON INFLATUM, B., C., and R. Ann. Mag. N. H., ser. iv, vol. ii, p. 33, pl. v, figs. 8—10 (figured but not described).

Carapace, as seen from the side, subrhomboidal, highest in the middle, height equal to two thirds of the length; anterior extremity somewhat produced, rounded; posterior produced into an obtusely rounded median beak; superior margin boldly arched, gibbous; inferior convex in the middle along the line of the alæform process, slightly

<sup>1</sup> *Cytheropteron inornatum*, B. and R. (see Ann. and Mag. N. H. (1872), ser. iv, vol. ix, p. 61, pl. ii, figs. 1—3), is likewise only a stage of development of *C. alatum*. We therefore take this opportunity of withdrawing the name.

sinuated towards each extremity. Seen from above, broadly ovate or lozenge-shaped, with equally tapering and sharply mucronate extremities; greatest width situate in the middle and equal to rather more than half the length. End-view almost quadrate, scarcely at all tapering to the apex. Shell-surface densely and minutely punctate, on the ventral surface longitudinally striated; alæform processes evenly and boldly rounded and but slightly prominent.

Length,  $\frac{1}{40}$ th of an inch.

DISTRIBUTION. *Recent*.—Baffin's Bay, North Atlantic.

*Fossil*.—Scotland: Dryleys, Errol. Canada.

5. CYTHEROPTERON MONTROSIENSE, *nov. sp.* Plate VIII, figs. 28—36; Plate XIV, figs. 13—16.

1868. CYTHEROPTERON MONTROSIENSE, C., B., and R. Ann. Mag. N. H., ser. iv, vol. ii, p. 33, pl. v, figs. 1—5 (figured but not described).

Valves of the *female* (?), as seen from the side, oblong, subrhomboidal, nearly equal in height throughout, height equal to more than half the length; anterior margin broadly rounded; posterior obliquely truncate below, produced above into a broad laminar projection or beak; dorsal margin slightly convex, deeply sulcate behind and at its junction with the laminar process; ventral straight in front, convex behind; lateral protuberance very prominent, forming a large irregularly rounded projection behind the middle of the ventral margin. Outline, as seen from above, rhomboidal, widest behind the middle, extremities pointed, the posterior strongly mucronate. End-view broadly triangular, the sides very convex; lateral surfaces marked with large polygonal excavations, ventral surface longitudinally rugose. Shell of the *male* (?) higher in front, the dorsal margin sloping steeply backwards, lateral and posterior protuberances poorly developed, surface-markings smaller.

Length,  $\frac{1}{80}$ th of an inch.

It will be seen by reference to the figures that the two forms included in the foregoing description differ considerably in appearance, but it will also be observed that the smaller, which we suppose to be the male, would by a larger development of the posterior and lateral protuberances assume a shape almost identical with that of the larger form; and as the two occur in the same localities we think it best to regard them as varieties of the same species dependent probably upon sex or age. *C. Montrosiense* has been found in the recent state in company with *C. inflatum*.

The form figured in Plate XIV we at one time supposed to belong to a distinct

species, characterised by the tapering and acutely pointed posterior extremity, and by the absence of lateral alar projections, and of any surface-ornament except the very slightest punctation. More extended researches have, however, supplied us with numerous specimens in stages intermediate between this and the fully developed *C. Montrosiense*, showing the extremity becoming gradually more obtuse and upturned, the shell-surface putting on its characteristic sculpture, and the lateral processes in progress of development.

DISTRIBUTION. *Recent*.—Baffin's Bay.

*Fossil*.—Scotland: Tangyburn, Govan, Barrie, Elie, Dryleys, Errol, Annochie, King Edward's. England: Hopton Cliff. Ireland: Woodburn. Norway.

6. CYTHEROPTERON RECTUM, *Brady*. Plate XIV, figs. 17, 18.

1868. CYTHEROPTERON RECTUM, *Brady*. Monog. Rec. Brit. Ostrac., p. 476.

1869. — — *Brady and Robertson*. Ann. Mag. N. H., ser. iv,  
vol. iii, p. 372, pl. xx,  
figs. 6—8.

Carapace, seen laterally, oblong, quadrangular, very slightly higher in front than behind; height not equal to half the length; anterior extremity well rounded; posterior rounded off below, but only slightly above the middle; superior margin straight, terminated at each extremity by a distinct angular elevation, inferior slightly sinuated in front of the middle; seen from above, ovate, widest behind the middle, where the lateral alæ project slightly, forming an obtuse angle, rounded behind, acuminate in front; width equal to nearly half the length. Surface of the shell closely and minutely punctate, lateral alæ almost obsolete.

Length,  $\frac{1}{8}$ th of an inch.

Our single fossil specimen of this species was unfortunately lost when only one figure of it had been drawn. The lateral view given in our plate was, therefore, taken from a recent carapace.

DISTRIBUTION. *Recent*.—Shetland and West of Ireland.

*Fossil*.—Scotland: Crofthead.

7. CYTHEROPTERON ANGULATUM, *B. and R.* Plate VIII, figs. 37—40.

1872. CYTHEROPTERON ANGULATUM, *Brady and Robertson*. Ann. Mag. N. H.,  
ser. iv, vol. vi,  
p. 62, pl. ii, figs.  
7, 8.

Carapace, as seen from the side, oblong, subrhomboidal, highest in front of the middle, greatest height equal to more than half the length; anterior margin rounded, posterior subtruncate, slightly beaked above; dorsal margin highest in front of the middle, thence sloping steeply in front and more gently behind, slightly sinuated near the posterior extremity; ventral margin somewhat convex. Outline, seen from above, oblong-pentagonal, widest in front of the middle, thence tapering suddenly to the anterior extremity, which is acuminate, more gradually to the posterior, which is broad and truncate; sides irregularly waved and emarginate. Surface irregularly waved and rugose in a transverse direction; alæform process not very prominent, forming an irregularly excavated angular line just within the ventral margin.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Scotland.

*Fossil*.—Scotland: Duntroon, Crinan, West Tarbert, Kyles of Bute, Kilchattan, Cumbræ, Dumbarton, Dalmuir, Inch Lonaig. England: Bridlington. Canada.

#### Genus 10—BYTHOCYTHERE, G. O. Sars.

Valves subequal, smooth or very sparingly sculptured, almost destitute of hairs; thin and fragile. Hinge-joint quite simple or composed of a slight bar and furrow; no teeth. Upper antennæ elongated, seven-jointed; the second joint large and thick and bearing a seta on its anterior and posterior margins; the other joints suddenly much narrower, forming a long slender lash, which bears several setæ; penultimate joint linear and destitute of setæ. Lower antennæ tolerably robust, four-jointed; second joint large; flagellum long, biarticulate, its last joint long and setiform. Mandibles constricted above the distal extremity, strongly toothed; palp four-jointed, bearing a well-developed branchial plate, which is set with numerous ciliated setæ. Terminal lobes of the first pair of jaws very short and thick; branchial plate large, ovate, bearing numerous marginal ciliated setæ, and at the base four long and deflexed simple setæ. Feet elongated, terminal claw very long and slender, second and third joints bearing each a short apical seta; basal joint of the first pair furnished at the base with a small lobe, which bears two very large and densely ciliated, and two smaller and simple setæ. Abdomen ending in a very large and acuminate process; postabdominal lobes narrow and bearing three hairs. Eyes mostly absent.

The species grouped under this genus present two very distinct types, so far as the characters of the shell are concerned; but according to the investigations of G. O. Sars, the structure of the animal itself is the same in both types.

1. BYTHOCYTHERE SIMPLEX (*Norman*). Plate VII, figs. 20, 21.

1865. CYTHERE SIMPLEX, *Norman*. Nat. Hist. Trans. Northumberland and Durham, vol. i, p. 17, pl. v, figs. 1—4.  
 1865. BYTHOCYTHERE ACUMINATA, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 86.  
 1865. JONESIA SIMPLEX, *Brady*. Zool. Trans., vol. v, p. 363, pl. lvii, figs. 11 a—c.  
 1868. BYTHOCYTHERE SIMPLEX, *Brady*. Monog. Rec. Brit. Ostrac., p. 450, pl. xxxiii, figs. 23—27, pl. xl, fig. 8.

Carapace, as seen from the side, elongated, fusiform, nearly equal in height throughout, greatest height equal to considerably less than half the length. Anterior extremity evenly rounded, posterior tapering abruptly, and conspicuously acuminate below the middle; superior margin nearly straight, inferior gently convex in front, produced along the posterior two thirds into a much compressed convex keel, sloping steeply upwards behind. Outline, seen from above, acutely ovate, extremities acuminate; widest in the middle, where the width is equal to one third of the length. Surface perfectly smooth. Lucid spots about five, parallel, linear, oblong, forming an oval, obliquely set patch near the middle of the valve.

Length,  $\frac{1}{2}$ nd of an inch.

This remarkable species is known in a living state in Baffin's Bay, on the coasts of Norway, Scotland, and the north of England, and has a range of depth varying from low-water-mark to about sixty fathoms.

DISTRIBUTION. *Recent*.—Baffin's Bay, Norway; Great Britain.

*Fossil*.—Scotland: Duntroon, Loch Gilp, West Tarbert, Cartsdyke, Paisley, Dalmeir, Govan, Jordan Hill. Ireland: Woodburn.

2. BYTHOCYTHERE CONSTRICTA, *G. O. Sars*. Plate XVI, figs. 9, 10.

1865. BYTHOCYTHERE CONSTRICTA, *G. O. Sars*. Overs. Norg. Mar. Ostrac., p. 85.  
 — — — *Brady*. Monog. Rec. Brit. Ostrac., p. 451, pl. xxxv, figs. 47—52.

Carapace, as seen from the side, rhomboidal, height nearly equal throughout and exceeding half the length; anterior extremity obliquely rounded; posterior obliquely truncate, rounded off at its upper angle; superior margin straight; inferior slightly sinuated near the middle, convex and inclined upwards behind. Outline, as seen from above, lozenge-shaped, distinctly constricted in the middle. Surface of the shell marked with delicate grooves mostly running in a subconcentric manner, but frequently anastomosing, so

as to form an irregular reticulation; lateral protuberance rounded and not very prominent; centre of the valves marked by a deep and wide transverse sulcus.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Channel Islands.

*Fossil*.—Scotland: Tangy Burn, Duntroon, Dumbarton, Govan.

3. BYTHOCYTHERE ELONGATA, *nov. sp.* Plate II, figs. 4, 5.

Carapace, seen laterally, oblong, subelliptical, somewhat higher behind than in front, height equal to less than one half of the length; extremities rather obliquely rounded off; superior margin almost straight for the greater part of its course, but sloping gently towards the front; inferior nearly straight. Seen from above, compressed, ovate, somewhat suddenly tapered and obtusely pointed in front, prominently mucronate behind; greatest width less than the height and situated rather behind the middle of the shell. Shell transversely rugose in a waved manner, with a central transverse sulcus, such as is frequently observed in this and the preceding genus. Lower surface of the shell marked with longitudinal furrows.

Length,  $\frac{1}{10}$ th of an inch.

This species, in general appearance, bears some resemblance to *Cytheropteron rectum*, especially in its rugose sculpture and rounded angles.

DISTRIBUTION.—One specimen only was found at Girvan.

Genus 11—PSEUDOCYTHERE, *G. O. Sars.*

Shell thin and pellucid, having no distinct structure, rounded in front, produced behind. Hinge-joint simple. Upper antennæ bearing long setæ, 7-jointed; second joint thick and armed with a single seta on the middle of the anterior margin; last joint very long and narrow, linear, terminating in very long setæ; lower antennæ very slender, 5-jointed; flagellum long and slender. Mandibles small, with slender, curved, unguiform, teeth; palp narrow, 4-jointed; branchial appendage bearing long setæ. Terminal lobes of the first pair of jaws narrow; branchial plate large, elongate-ovate, armed towards the base with three curved and deflexed simple setæ. Feet very long and slender. Abdo-

men ending in a long, slender process ; postabdominal lobes almost as in the preceding genus. No eye.

*PSEUDOCYTHERE CAUDATA*, *G. O. Sars.* Plate II, fig. 9.

*PSEUDOCYTHERE CAUDATA*, *G. O. Sars.* Overs. Norg. mar. Ostrac., p. 88.

— — *Brady.* Monog. Rec. Brit. Ostrac., p. 453, pl. xxxiv, figs. 49—52 ; pl. xli, fig. 6.

Carapace of the *male*, as seen from the side, quadrilateral, highest in front ; greatest height equal to more than half the length. Anterior margin broad and well rounded ; posterior obliquely truncate, produced above into an obtusely conical beak ; superior margin sloping in a somewhat sinuous line from before backwards ; inferior slightly sinuated in front, terminating behind in one or two small sharp teeth. The anterior and ventral margins form a thin flattened lamina, which (in recent specimens) is marked with radiating transverse lines, and is most strongly developed behind. Shell of the *female* rather more tumid. Outline, as seen from above, compressed, tapering to the extremities, which are slightly mucronate ; greatest width in the middle and equal to one third of the length. Shell smooth, thin, and fragile ; pellucid. Lucid spots four, linear, parallel, situated obliquely a little in front of the middle.

Length,  $\frac{1}{10}$ th of an inch.

DISTRIBUTION. *Recent.*—Norway, Great Britain and Ireland.

*Fossil.*—Scotland : Blackburn, Dalmuir, Raised-beach, Oban. Ireland : Woodburn.

Genus 12—*CYTHERIDEIS*, *Jones.*

Carapace elongated, subovate, depressed in front ; hinge-margins nearly simple. Shell smooth, punctate, sometimes grooved ; right valve overlapping the left in the centre of the ventral aspect. Superior antennæ slender, sparingly setose ; last joint short and bearing six short terminal setæ ; penultimate and antepenultimate joints each bearing a single apical seta. Mandible slender and curved, divided below into about four very small indistinct teeth ; palp four-jointed, its first joint bearing on the inferior margin a conical tooth-like process ; third joint set along its entire length with a comb-like series of straight equal setæ ; in other respects like that of *Cythere*. First segment of the maxillæ much stouter and larger than the rest.

*CYTHERIDEIS SUBSPIRALIS*, nov. sp. Plate X, figs. 16, 17.

Valves, as seen from the side, oblong, depressed in front, height equal to not much more than one third of the length; extremities rounded; the anterior much narrowed; superior margin straight, but suddenly sloping forwards with a gentle declivity from about the anterior third; inferior margin almost straight. Seen from above, compressed, ovate. Shell-surface marked with several curved or transversely spiral furrows, and on the anterior half with distant circular pittings.

Length,  $\frac{1}{8}$ th of an inch.

Except the British *C. subulata*, the only near relative of this curious species, with which we are acquainted, is a still more compressed and elongated form found living in the Mediterranean and amongst the Cape de Verd Islands, and described by Mr. Brady, in 'Les Fonds de la Mer,' under the name *Cytherideis cylindrica*. One valve only of *C. subspiralis* has been discovered.

DISTRIBUTION. *Fossil*.—Scotland: Wick.

Genus 13—*SCLEROCHILUS*, G. O. Sars.

Valves elongated, very hard, especially towards the margins; surface smooth and shining, ornamented with very minute scattered papillæ. Hinge-joint formed by a projecting median crest of the left valve. Lucid spots linear, subparallel, forming an oblique oval patch below the centre of the valve. Antennæ robust; second joint of the upper bearing a seta on the anterior and posterior margins, the last five joints quickly decreasing in size and bearing numerous long setæ; lower antennæ larger than the upper, 5-jointed; flagellum long and very slender. Poison-glands very large, and divided into many lobes. Mouth produced, conical; labrum strongly toothed. Mandibles small; teeth numerous and acuminate; palp narrow, indistinctly 3-jointed, with a distinct branchial appendage. Terminal lobes of the first pair of jaws partly wanting; branchial plate narrow, almost lanceolate, and beset with numerous setæ on the outer and inner margins. Feet short and robust; second and third joints armed in front with a sharp seta; first pair armed with a single strong spine at the apex of the basal joint. Post-abdominal lobes larger than usual, forming broad bilobed laminæ, and bearing five setæ. Eye single.



*SCLEROCHILUS CONTORTUS* (*Norman*). Plate X, figs. 33—35.

1862. *CYTHERE CONTORTA*, *Norman*. Ann. Mag. N. H., vol. ix, p. 48, pl. ii, fig. 15;  
Trans. Tyneside Nat. F. C., vol. v, p. 150,  
pl. iii, fig. 15.
1865. *SCLEROCHILUS CONTORTUS*, *Sars*. Overs. Norg. mar. Ostrac., p. 90.
1868. — — — *Brady*. Monog. Rec. Brit. Ostrac., p. 455, pl.  
xxxiv, figs. 5—10; pl. xli, fig. 7.

Shell of the *female*, as seen from the side, elongated, bean-shaped, higher behind than in front, greatest height less than one half of the length, situated behind the middle. Extremities well rounded; superior boldly arched; inferior deeply sinuated in front of the middle. Seen from above, compressed, ovate, extremities acutely pointed, width scarcely equal to one third of the length. End-view ovate, rounded above, pointed below. Surface perfectly smooth. Colour yellowish.

Length,  $\frac{1}{4}$ th of an inch.

DISTRIBUTION. *Recent*.—Britain, Norway, Bay of Biscay, Spitzbergen.

*Fossil*.—Scotland: in nearly all the Post-tertiary beds. South Wales: Cardiff New Dock-basin. Ireland: Belfast New Dock, Portrush. Norway and Canada.

#### Genus 14—*PARADOXOSTOMA*, *Fischer*.

Shell thin and fragile, smooth, shining, and having no definite structure; valves sub-equal, mostly much higher behind than in front, usually elongate-ovate. Lucid spots as in the preceding genus. Hinge-joint simple. Ventral margins emarginate in front, so that when the valves are closed there is still an elongated orifice through which the suctorial mouth can be protruded. Upper antennæ exceedingly slender, 6-jointed, and bearing short setæ; lower shorter and more robust, 5-jointed; flagellum large and almost as thick as the antenna itself. Poison-glands large and mostly lobulated. Mouth suctorial. Labrum and labium forming together a large and stout subconical process projecting downwards, and terminating in a disk with elevated margins, in the middle of which the orifice of the mouth is situated. Mandibles very slender, protractile, styliform, subulate at the apex; palp very slender and elongated, indistinctly jointed

and without a branchial appendage. Terminal lobes of the first pair of jaws very narrow; branchial plate elongate-ovate, and bearing at the base two deflexed setæ. Feet short and robust, last joint elongated, terminal claw very short and curved; basal joint of the first pair armed at the apex with a single strong spine. Postabdominal lobes bearing two short hairs. One eye.

1. *PARADOXOSTOMA VARIABILE* (*Baird*). Plate X, figs. 29—32.

1792. ♀ *CYTHERE FLAVIDA*, *Müller*. Entomostraca, p. 66, pl. vii, figs. 5, 6.  
 1835. — *VARIABILIS*, *Baird*. Trans. Berwickshire Nat. Club, vol. i, p. 98,  
 pl. iii, figs. 7 *a—b*; vol. ii, p. 153; (1850)  
 Brit. Entom., p. 170, pl. xxi, figs. 10, 11.  
 1865. *PARADOXOSTOMA VARIABILE*, *Sars*. Overs. Norg. mar. Ostrac., p. 93.  
 1868. — — *Brady*. Monog. Rec. Brit. Ostrac., p. 457, pl.  
 xxxv, figs. 1—7, 12—17; pl. xli,  
 fig. 8.

Carapace, as seen from the side, pear-shaped, much higher behind than in front; greatest height equal to half the length, situated behind the middle; anterior extremity narrowly, posterior broadly rounded; superior margin well arched, sloping more steeply in front than behind; inferior convex behind the middle. Outline, as seen from above, compressed, ovate, tapering gradually to the acuminate extremities; greatest width behind the middle, slightly exceeding one third of the length. End-view obovate, widest above the middle. Shell-surface perfectly smooth.

Length,  $\frac{1}{40}$ th of an inch.

We do not remember to have seen any fossil shells of this species marked with the dark-coloured maculæ, which are so constant in recent littoral examples. This may arise either from their having inhabited water of considerable depth or possibly from loss of the original colouring during the ages which have elapsed since their death.

**DISTRIBUTION.** *Recent*.—Baffin's Bay, Spitzbergen, Great Britain, Norway, Holland.

*Fossil*.—Scotland: Tangy Burn, Duntroon, Loch Gilp, Blackburn, Kyles of Bute, Cumbrae, Dumbarton, Cartdyke, Paisley, Govan, West Tarbert, Raised Beach at Oban. Ireland: Woodburn, Belfast New Docks. Norway and Canada.

## 2. PARADOXOSTOMA ABBREVIATUM, G. O. Sars.

1865. PARADOXOSTOMA ABBREVIATUM, G. O. Sars. Overs. Norg. mar. Ostrac. p. 94.

1868. — — — Brady. Monog. Rec. Brit. Ostrac., p. 458, pl. xxxv, figs. 22—25.

Carapace of the *female*, as seen from the side, much shorter and higher than the preceding; greatest height behind the middle and equal to about two thirds of the length; extremities rounded; anterior narrow; posterior excessively broad; superior margin boldly arched; inferior deeply sinuated in front, very convex behind. Outline, as seen from above, compressed, ovate, about three times as long as broad. Shell of the *male* and *young females* lower; inferior margin less convex behind.

Length,  $\frac{1}{4}$ th of an inch.

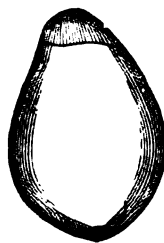
DISTRIBUTION. *Recent*.—Great Britain, Ireland, Norway.

*Fossil*.—Scotland: Loch Gilp, Oban. South Wales: Cardiff.

3. PARADOXOSTOMA (?) PYRIFORME, *nov. sp.* Woodcut, figs. 1—3.

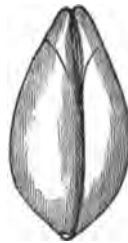
Carapace, as seen from the side, broadly pear-shaped, narrowed at the anterior and broadly rounded at the posterior extremity; superior and inferior margins nearly alike, gently sinuated in front and boldly convex at and behind the middle; greatest height

FIG. 1.



Side view.

FIG. 2.



Edge view.

FIG. 3.



End view.

equal to more than two thirds of the length and situated near the middle; seen from above the outline is subovate, suddenly tapered and acuminate behind, more gently tapering and subacuminate in front, greatest width a little behind the middle and equal

to about one half the length; end view broadly oval. Shell smooth and polished, milk-white, tipped with a small pellucid areola at each extremity.

Length,  $\frac{1}{80}$ th of an inch.

Three or four examples of this very distinct species were found in the Bridlington deposit, but too late to be figured in our lithographic plates. It has the general aspect of a *Paradoxostoma*, but we have failed to find the mandibular aperture characteristic of that species; neither are the lucid spots visible. Moreover, there is an indistinct appearance of overlapping of the left valve on the dorsal surface, so that we cannot but consider the position here assigned to it somewhat doubtful. In lateral outline it is extremely like *P. abbreviatum* (which species we have by some oversight omitted to include in our plates), but when viewed from above is much more tumid.

4. *PARADOXOSTOMA ENSIFORME*, *Brady*. Plate 10, figs. 27, 28.

1868. *PARADOXOSTOMA ENSIFORME*, *Brady*. Monog. Rec. Brit. Ostrac., p. 460, pl. xxxv, figs. 8—11.

Valves, as seen from the side, somewhat scimitar-shaped, much higher behind than in front, greatest height scarcely equal to half the length, situated behind the middle; anterior extremity obtusely pointed; posterior obliquely rounded, slightly produced above the middle; superior margin boldly arched; inferior gently sinuated in the middle. Seen from above, compressed, ovate, with pointed extremities. Shell smooth, yellowish.

Length,  $\frac{1}{85}$ th of an inch.

Our fossil specimens differ somewhat in shape from the recent form as found in the British islands, and are, perhaps, more exactly similar to specimens taken in the Mediterranean, and referred by Mr. Brady to the same species.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Levant.

*Fossil*.—Scotland: Kyles of Bute. South Wales: Cardiff New Dock basin. England: Bridlington. Ireland: Belfast New Docks, Portrush.

5. *PARADOXOSTOMA FISCHERI*, *G. O. Sars*. Plate XVI, figs. 23, 24.

1865. *PARADOXOSTOMA FISCHERI*, *G. O. Sars*. Overs. Norg. mar. Ostrac., p. 96.

1870. — — *Brady*. Nat. Hist. Trans. Northumberland and Durham, vol. iii, p. 362, pl. xii, figs. 1—3.

1869. *SCLEROCHILUS* (?) *GRACILIS*, *Brady and Robertson*. *Ann. Mag. N. H.*, ser. iv, vol. iii, pl. xx, figs. 11, 12.

Carapace, seen laterally, elongated, subtriangular, greatest height situated in the middle, and equal to less than half the length; extremities nearly equal, narrowed, and sharply rounded, superior margin very boldly and evenly arched, inferior gently sinuated in the middle. Seen from above, ovate, with equal obtusely pointed extremities; greatest width situated in the middle, rather less than the height. Shell-surface smooth, destitute of ornament of any kind, but in recent specimens often beautifully banded with dark olive or black.

Length,  $\frac{1}{8}$ th of an inch.

DISTRIBUTION. *Recent*.—Britain, Ireland, Norway.

*Fossil*.—Scotland: Loch Gilp, Carlsdyke, West Tarbert. South Wales: Cardiff New Dock-basin. Ireland: Belfast New Dock.

6. *PARADOXOSTOMA FLEXUOSUM*, *Brady*. Plate XVI, figs. 19, 20.

1866. *BYTHOCYTHERE* (?) *FLEXUOSA*, *Brady*. *Brit. Assoc. Report*, 1866, p. 211.  
 1868. *PARADOXOSTOMA FLEXUOSUM*, *Brady*. *Monog. Rec. Brit. Ostrac.*, p. 461, pl. xxxv, figs. 30—34.  
 1872. — — — *Brady and Robertson*. *Ann. Mag. N. H.*, ser. iv, vol. ix, p. 55, pl. i, figs. 8, 9.

Carapace, seen laterally, elongated, flexuous, greatest height situated near the middle, and equal to rather more than one third of the length; extremities sharply rounded, the anterior being the narrower and more acute, superior margin boldly and equally arched, inferior distinctly sinuated in front of the middle, gently convex behind. Seen from above, much compressed, ovate, extremities acuminate, greatest width in the middle, and equal to about one fourth of the length. Surface of the shell smooth, marked usually with very faint and delicate longitudinal striæ.

Length,  $\frac{1}{8}$ th of an inch.

The longitudinal striations referred to in this description are imperceptible except with a tolerably high microscopic power, and they exist probably in all—certainly in many others—of the genus.

DISTRIBUTION. *Recent*.—Britain.

*Fossil*.—Scotland: Loch Gilp. South Wales: Cardiff New Dock-basin.

7. PARADOXOSTOMA TENERUM, *nov. sp.* Plate XVI, figs. 21, 22.

Almost exactly like *P. flexuosum*, except that, when seen laterally, the anterior extremity is more widely rounded, and the superior margin more boldly arched in the middle; the dorsal aspect presents also a more compressed outline, while the surface of the shell is slightly papillose, with hair-like markings along the ventral margin. The length is also greater, being about  $\frac{1}{8}$ th of an inch. Yet notwithstanding these differences we have still some misgivings as to its title to rank as a distinct species.

DISTRIBUTION. *Fossil*.—Scotland: Dumbarton, Cartsdyke, Dalmuir.

8. PARADOXOSTOMA ARCUATUM, *Brady*. Plate XVI, fig. 25.

1868. PARADOXOSTOMA ARCUATUM, *Brady*. Monog. Rec. Brit. Ostrac., p. 461, pl. xxxv, figs. 37, 38.

Carapace, seen from the side, oblong, subtriangular, highest in the middle, height equal to a little more than one third of the length, extremities moderately rounded, superior margin well and evenly arched, inferior almost straight. Seen from above, compressed, ovate, widest behind the middle, width equal to one fourth of the length. Shell quite smooth.

Length,  $\frac{1}{4}$ th of an inch.

DISTRIBUTION. *Recent*.—West of Ireland, Shetland.

*Fossil*.—Scotland: Raised-beach at Oban.

## Family 4—CYPRIDINADÆ.

Genus 1—ASTEROPE, *Philippi*.

Shell subcylindrical, beak not at all produced. Upper antennæ six-jointed; in the *female* short and thick, and bearing several subequal terminal setæ of moderate length; in the *male* more elongated, two of the terminal setæ of excessive length, the antepenultimate joint bearing a stout and densely setose auditory filament. Second joint of the natatory branch of the lower antennæ in the *male* elongated, in the

*female* scarcely longer than the succeeding joints; secondary branch in the *male* robust, subchelate; terminal joint slender, curved upwards; in the *female* simple, triarticulate, last joint setiform. First jaw consisting of a broad, subquadrate, or crescentic lamina densely clothed on its distal margin with long bristles; second jaw swollen at the base, narrowed at the apex, where it bears six plumose setæ, basal portion setose along its convex margin; third jaw narrow, elongated, setose along the inner margin. Post-abdominal laminae short and broad, subtruncate at the apex.

In external appearance this genus is chiefly distinguished from others of its family by the cylindrical form of the shell and the absence of a projecting beak.

ASTEROPE TERES (*Norman*). Plate II, figs. 33, 34.

1861. CYPRIDINA TERES, *Norman*. Ann. Mag. N. H., vol. viii, pl. xiv, fig. 10.

1868. CYLINDROLEBERIS TERES, *Brady*. Monog. Rec. Brit. Ostrac., p. 465, pl. xxxiii, figs. 6—9, and pl. xli, fig. 2.

1871. ASTEROPE — *Brady*. Proc. Zool. Soc. Lond., 1871, p. 295.

Shell, seen laterally, almost elliptical, wider behind than in front, the greatest height behind the middle and equal to at least two thirds of the length. Anterior extremity slightly narrowed and somewhat flattened, with a wide, but shallow, notch below the middle; obtusely subangular below, rounded off above; posterior extremity broad, boldly and evenly rounded; superior margin evenly and well arched; inferior almost straight for the first half of its course, but curved posteriorly. Seen from above, oblong-ovate, anterior extremity narrowly, posterior rather broadly, rounded; greatest width situated near the middle, and equal to nearly half the length. Surface of the shell smooth, dense and calcareous in structure.

Length,  $\frac{1}{18}$ th of an inch.

It is extremely probable that this is only the female of the much more commonly seen *Asterope Mariae*, which differs, however, very considerably in external appearance, being much longer and more compressed, more delicate in shell structure and variously coloured. The anatomy of the two animals is, however, essentially the same, and the points of difference are such as might be expected to accompany difference of sex, though, doubtless, very strongly developed in this instance. The male, being provided with swimming filaments, is usually taken near the surface of the water, while the female is never met with except in the dredge. Under these circumstances we need scarcely expect to find the male in the fossil state.

DISTRIBUTION. *Recent*.—North Sea, West Coasts of Scotland and Ireland, Scilly, and Channel Islands.

*Fossil*.—Scotland: Jordan Hill.

*Family 5—POLYCOPIDÆ.**Genus 1—POLYCOPE, G. O. Sars.*

Valves rounded, ventricose, thin, and fragile, corneo-calcareous. Forehead having no tentacle, but in its place two ciliated setæ. Upper antennæ three-jointed, last joint short, terminal setæ long and slender; terminal rami of the lower antennæ unequal, one many-jointed, of structure very similar to that of *Cypridina*, the other shorter and three-jointed. Lower extremity of mandibles strongly inflexed, armed with a few small acute teeth; palp biarticulate, first joint stout, bearing externally a short, bisetose, branchial appendage; last narrow, beset with long plumose setæ. Incisive portion of the first pair of jaws small, forming a simple setiferous lobe; palp very large, four-jointed, two-branched, second joint bearing externally a long, narrow, and obsoletely biarticulate branch, which is terminated by long setæ. Second pair of jaws membranaceous, three-jointed; penultimate joint bearing externally a small branch which terminates in a single seta; furnished at the base with a large branchial plate. Postabdominal plates short, posterior margin shortly digitate and armed between the segments with acuminate claws. Animal swimming actively like the Lynceidæ.

POLYCOPE ORBICULARIS, *G. O. Sars.* Plate XII, figs. 22, 23.

1865. POLYCOPE ORBICULARIS, *G. O. Sars.* Overs. Norg. mar. Ostrac., p. 122.

1868. — — — *Brady.* Monog. Rec. Brit. Ostrac., p. 471, pl. xxxv, figs. 53—57.

Shell subspheroidal; as seen from the side, almost circular, somewhat flattened on the dorsal margin. Seen from above, ovate, tapering evenly to each extremity, greatest width situated in the middle, equal to more than half the length. Surface of the shell finely and closely punctate, and mostly divided by delicate raised ridges into numerous polygonal areolæ.

Diameter,  $\frac{1}{7}$ nd of an inch.

There is a good deal of diversity in the surface-ornament of this species. The specimens from Dalmuir, one of which is figured in our plate, are distinctly areolated, but the puncta are small and faint; the Paisley specimens, on the contrary, are much more strongly punctate, and others are almost entirely destitute of sculpture of any kind.



DISTRIBUTION. *Recent*.—Norway, Great Britain, Ireland, Spitzbergen.

*Fossil*.—Scotland: Duntroon, Dumbarton, Cartdyke, Paisley, Old Mains, Govan, Dalnair.

*Family 6—CYTHERELLIDÆ ?*

*Genus 1—BOSQUETIA, nov. gen.*

Shell dense and thick, the right valve much larger than the left and overlapping both on the dorsal and ventral margins; valves obliquely ovate, higher in front than behind; greatest width in the middle; hinge-joints formed apparently by an overlapping of the dorsal margin of the right valve at each extremity.

One specimen only of this new genus having occurred to us, we are unable to give its characters with the certainty and minuteness which we could have wished, but an examination of this single example leaves us unable to assign it to any known genus. It differs from the *Cypridinadæ* in the absence of any antennal notch, and from the *Cytherellidæ* in the structure of the hinge-joint, in the general contour of the shell, and probably also in the character of the muscle-spots; but of this latter point we cannot speak confidently.

*BOSQUETIA ROBUSTA, nov. sp.* Plate XII, figs. 18—21.

Carapace, as seen from the side, higher in front than behind; greatest height equal to nearly three fourths of the length; anterior extremity broadly rounded; posterior rounded, somewhat narrowed and prominent in the middle; superior margin arched, flattened in the middle; inferior boldly convex, forming with the anterior margin one continuous sweep. Seen from above, ovate, widest near the middle; width fully equal to half the length, extremities broadly acuminate, tapering more abruptly behind than in front. Surface of the shell perfectly smooth.

Length,  $\frac{1}{30}$ th of an inch.

DISTRIBUTION. *Fossil*.—Scotland: Paisley.

## § X. SUPPLEMENTARY.

[The following have been accidentally omitted from their proper positions in the descriptive portion of this Memoir.]

42. *CYTHERE ROBERTSONI*, *Brady*.

1868. *CYTHERE ROBERTSONI*, *Brady*. *Ann. Mag. N. H.*, ser. iv, vol. ii, p. 33, pl. iv, figs. 5, 8—10.

Shell of the *female* compressed, subcuneiform, much higher in front than behind; greatest height situated in front and equal to somewhat more than half the length; extremities obliquely rounded; anterior broad, posterior narrowed; superior margin straight, sloping steeply from before backwards; inferior sinuated in the middle, curved upwards behind. Seen from above, compressed, oblong, with nearly parallel sides; anterior extremity acuminate, posterior suddenly tapered and obtusely pointed; width much less than the height. End-view ovate, widest in the middle. Shell of the *male* much narrower; surface of the shell covered with closely set angular pittings.

Length,  $\frac{1}{8}$ nd of an inch.

DISTRIBUTION. *Recent*.—Great Britain, Ireland, Norway.

*Fossil*.—Scotland: Loch Gilp. Norway.

20. *CYTHERURA ROBERTSONI*, *Brady*.

1868. *CYTHERURA ROBERTSONI*, *Brady*. *Monog. Rec. Brit. Ostrac.*, p. 444, pl. xxxii, figs. 16—18.

Carapace of the *female*, as seen from the side, subovate, produced into a lateral ala behind the middle of the ventral margin; height equal to more than half the length; anterior extremity rounded, posterior slightly produced in a rounded manner above the middle. Superior margin gently and evenly arched, inferior slightly sinuated. Seen from above, subrhomboidal, widest behind the middle, extremities slightly mucronate; width equal to about two thirds of the length. End-view broadly triangular, with much produced basal angles; width greater than the height. The shell of the *male* is more elongated, more sinuated below, and has less prominent lateral alæ. Shell-surface very distinctly and regularly marked with a raised reticulation; ventral surface longitudinally striated.

Length,  $\frac{1}{8}$ nd of an inch.

DISTRIBUTION. *Recent*.—Great Britain.

*Fossil*.—Scotland: West Tarbert Silt. Canada: Saxicava Sand, Montreal.

§ XI. TABLE ILLUSTRATING THE DISTRIBUTION OF

The asterisk denotes the comparative rarity of the species.    × × × Represent abundance, × × moderate frequency.

|                          | Boulder Clay, Wick. | Lag Arran. | Tangy Burn, Campbellton. | King Edward's, near Banff. | Crothead, Renfrewshire. | Paisley. | Stobcross, Glasgow. | Jordan Hill, near Glasgow. | Govan, near Glasgow. | Rowan Bridge, near Glasgow. | Old Mains, Renfrewshire. | Dalmuir. | Dumbarton. | Inch Lonaig, Loch Lomond. | Cartsdyke, Greenock. | Cumbræ, College-bed, Bute. | Kilchattan, Bute. | Kyles of Bute. | East Tarbert, Argyllshire. | West Tarbert, Argyllshire. | Loch Gilly, Argyllshire. |
|--------------------------|---------------------|------------|--------------------------|----------------------------|-------------------------|----------|---------------------|----------------------------|----------------------|-----------------------------|--------------------------|----------|------------|---------------------------|----------------------|----------------------------|-------------------|----------------|----------------------------|----------------------------|--------------------------|
| CYPRIS, Müller—          |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| compressa, Baird         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| salina, Brady            | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| virens (Jurine)          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| ovum (Jurine)            | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| lævis, Müller            | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| cinerea, Brady           | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| gibba, Ramdohr           | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| reptans (Baird)          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| CYPRIDOPSIS, Brady—      |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| obesa, B. & R.           | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| Newtoni, B. & R.         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| POTAMOCYPRIS, Brady—     |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| fulva, Brady             | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| PARACYPRIS, G. O. Sars—  |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| polita, G. O. Sars       | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| ARGILLOECIA, G. O. Sars— |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| cylindrica, G. O. Sars   | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| CANDONA, Baird—          |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| albicans, Brady          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| detecta (Müller)         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| lactea, Baird            | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| compressa (Koch)         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| candida (Müller)         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| PONTOCYPRIS, G. O. Sars— |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| mytiloides, Norman       | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| trigonella, G. O. Sars   | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| acupunctata, Brady       | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| AGLATA, Brady—           |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| glacialis, n. sp.        | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| BAEDIA, M' Coy—          |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| inflata, Norman          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| Cambrica, n. sp.         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| DARWINELLA, B. & R.—     |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| Stevensoni, B. & R.      | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| CYTHERE, Müller—         |                     |            |                          |                            |                         |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                   |                |                            |                            |                          |
| pellucida, Baird         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| castanea, G. O. Sars     | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| porcellanea, Brady       | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| Macallana, B. & R.       | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| tenera, Brady            | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| deflexa, n. sp.          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| cribrosa, n. sp.         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| crispata, Brady          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| viridis, Müller          | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| lutea, Müller            | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| albomaculata, Baird      | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| leioderma, Norman        | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| gibbosa, B. & R.         | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| convexa, Baird           | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |
| cicatricosa (Reuss)      | ...                 | ...        | ...                      | ...                        | ...                     | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...               | ...            | ...                        | ...                        | ...                      |

## OSTRACODA OVER POST-TERTIARY LOCALITIES.

nd x rarity. Localities additional to those given in the text are assigned in this Table to some species.

[illegible]

|                                   | Boulder Clay, Wick. | Lag Arran. | Tangy Burn, Campbellton. | King Edward's, near Banff. | Crofthead, Renfrewshire. | Paisley. | Stobcross, Glasgow. | Jordan Hill, near Glasgow. | Govan, near Glasgow. | Rowan Bridge, near Glasgow. | Old Maids, Renfrewshire. | Dalmuir. | Dumbarton. | Inch Lonaig, Loch Lomond. | Cartsdyke, Greenock. | Cumbræ, College-bed, Bute. | Kilchatan, Bute. | Kyles of Bute. | East Tarbert, Argyllshire. | West Tarbert, Argyllshire. | Loch Gill, Argyllshire. |
|-----------------------------------|---------------------|------------|--------------------------|----------------------------|--------------------------|----------|---------------------|----------------------------|----------------------|-----------------------------|--------------------------|----------|------------|---------------------------|----------------------|----------------------------|------------------|----------------|----------------------------|----------------------------|-------------------------|
| <b>CYTHERE, Müller (cont.)—</b>   |                     |            |                          |                            |                          |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                  |                |                            |                            |                         |
| <i>Clutha</i> , n. sp.            | ...                 | x          | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | x                    | ...                         | ...                      | ...      | ...        | ...                       | x                    | ...                        | x                | ...            | ...                        | ...                        | ...                     |
| <i>Finmarchica</i> (G. O. Sars)   | x                   | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>cuneiformis</i> , Brady        | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>limicola</i> (Norman)          | ...                 | ...        | x x                      | ...                        | ...                      | ...      | x                   | ...                        | ...                  | ...                         | ...                      | ...      | x          | x                         | x                    | x                          | x x              | x x            | ...                        | ...                        | ...                     |
| <i>globulifera</i> , Brady        | ...                 | ...        | x                        | ...                        | ...                      | x x      | ...                 | x                          | x x                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>Jeffreysii</i> , Brady         | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>pulchella</i> , Brady          | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | x                          | ...                  | ...                         | ...                      | ...      | x          | ...                       | ...                  | x x                        | x x              | ...            | ...                        | x                          | ...                     |
| <i>villosa</i> (G. O. Sars)       | x                   | ...        | ...                      | ...                        | ...                      | ...      | x x                 | x x                        | x                    | x x                         | x x                      | x x      | x          | x                         | x x                  | x x                        | x x              | x x            | x x                        | x x                        | x x                     |
| <i>laticarina</i> , Brady         | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>macropora</i> , Bosq.          | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>concinna</i> , Jones           | x                   | x x        | x x                      | ...                        | ...                      | x x      | x                   | x x                        | x x                  | x x                         | x                        | x x      | x x        | x x                       | x x                  | x x                        | x x              | x x            | x x                        | x x                        | x x                     |
| <i>emaciata</i> , Brady           | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>quadridentata</i> , Baird      | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>angulata</i> (G. O. Sars)      | ...                 | ...        | ...                      | ...                        | ...                      | x x      | ...                 | ...                        | ...                  | ...                         | x x                      | x x      | x x        | x                         | x x                  | x x                        | x x              | x x            | x x                        | x x                        | x x                     |
| <i>latimarginata</i> , Speyer     | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>tuberculata</i> (G. O. Sars)   | x                   | ...        | ...                      | x                          | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | x x                      | x x      | x x        | x x                       | x x                  | x x                        | x x              | x x            | x x                        | x x                        | x x                     |
| <i>Logani</i> , B. & C.           | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>emarginata</i> (G. O. Sars)    | ...                 | x          | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | x                          | ...                     |
| <i>costata</i> , Brady            | ...                 | ...        | ...                      | ...                        | ...                      | x        | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>mirabilis</i> , Brady          | x                   | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>Hoptonensis</i> , n. sp.       | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>Dunelmensis</i> (Norman)       | x                   | x          | x x                      | x x                        | ...                      | x x      | x x                 | x                          | x x                  | x x                         | x                        | x        | x          | x                         | ...                  | x                          | x x              | x x            | x x                        | ...                        | x x                     |
| <i>Whiteii</i> (Baird)            | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>antiquata</i> (Baird)          | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>Jonesii</i> (Baird)            | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| — var. <i>ceratoptera</i> , Bosq. | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| ? <i>semipunctata</i> , Brady     | ?                   | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>Robertsoni</i> , Brady         | ...                 | ...        | ...                      | ...                        | ...                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <b>LYMNIOCYTHERE, Brady—</b>      |                     |            |                          |                            |                          |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                  |                |                            |                            |                         |
| <i>inopinata</i> (Baird)          | ...                 | ...        | ...                      | ...                        | x x                      | ...      | ...                 | ...                        | ...                  | ...                         | ...                      | ...      | ...        | ...                       | ...                  | ...                        | ...              | ...            | ...                        | ...                        | ...                     |
| <i>Sancti Patricii</i> , B. & R.  | ...                 |            |                          |                            |                          |          |                     |                            |                      |                             |                          |          |            |                           |                      |                            |                  |                |                            |                            |                         |



|                                    | Boulder Clay, Wick. | Lag Arran. | Tangy Burn, Campbellton. | King Edward's, near Bang. | Crofthead, Renfrewshire. | Paisley. | Stobcross, Glasgow. | Jordan Hill, near Glasgow. | Govan, near Glasgow. | Rowan Bridge, near Glasgow. | Old Maina, Renfrewshire. | Dalmuir. | Dumbarton. | Inch Lonaig, Loch Lomond. | Cardryke, Greenock. | Cumbræ, College-bod, Bute-shire. | Kilchattan, Bute. | Kyles of Bute. | East Tarbert, Argyllshire. | West Tarbert, Argyllshire. | Loch (Gill), Argyllshire. |
|------------------------------------|---------------------|------------|--------------------------|---------------------------|--------------------------|----------|---------------------|----------------------------|----------------------|-----------------------------|--------------------------|----------|------------|---------------------------|---------------------|----------------------------------|-------------------|----------------|----------------------------|----------------------------|---------------------------|
| <b>CYTHERRA, G. O. Sars—</b>       |                     |            |                          |                           |                          |          |                     |                            |                      |                             |                          |          |            |                           |                     |                                  |                   |                |                            |                            |                           |
| nigrescens (Baird).....            | ..                  | x          | x x                      | ..                        | ..                       | ..       | x                   | x                          | x x                  | x x                         | x x                      | x x      | x x        | x x                       | ..                  | x x                              | x x               | x x            | x x                        | x                          | x                         |
| similis, G. O. Sars.....           | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | x x                 | x x                              | x x               | x x            | x                          | x                          |                           |
| pumila, n. sp.....                 | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| concentrica, n. sp.....            | ..                  | ..         | ..                       | ..                        | ..                       | x x      | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| complanata, n. sp.....             | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| undata, G. O. Sars.....            | x                   | x          | x x                      | ..                        | ..                       | x x      | ..                  | x                          | x                    | x                           | x                        | x x      | x x        | x x                       | x x                 | x x                              | x x               | x              | x x                        | x                          |                           |
| compressa, n. sp.....              | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| striata, G. O. Sars.....           | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| quadrata, Norman.....              | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | x x                 | x                                | ..                | x x            | ..                         | ..                         |                           |
| cuneata, Brady.....                | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| Sarsii, Brady.....                 | ..                  | ..         | ..                       | ..                        | ..                       | x x      | ..                  | ..                         | ..                   | ..                          | ..                       | x x      | ..         | ..                        | ..                  | ..                               | ..                | x              | x                          | ..                         |                           |
| angulata, Brady.....               | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | x x                 | x x                              | ..                | x              | x                          | ..                         |                           |
| producta, Brady.....               | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| cornuta, Brady.....                | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| Robertsoni, Brady.....             | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| gibba (Müller).....                | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | x                          | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | x                 | ..             | ..                         | ..                         |                           |
| flavescens, Brady.....             | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | x              | ..                         | ..                         |                           |
| acuticostata, G. O. Sars.....      | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | ..                         | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| cellulosa (Norman).....            | ..                  | ..         | ..                       | ..                        | ..                       | ..       | ..                  | x                          | ..                   | ..                          | ..                       | ..       | ..         | ..                        | ..                  | ..                               | ..                | ..             | ..                         | ..                         |                           |
| clathrata, G. O. Sars.....         | ..                  | ..         | x x                      | ..                        | ..                       | x x      | ..                  | x                          | ..                   | ..                          | x                        | x x      | x          | x                         | x x                 | x                                | ..                | ..             | x                          | ..                         |                           |
| <b>CYTHEROPTERON, G. O. Sars—</b>  |                     |            |                          |                           |                          |          |                     |                            |                      |                             |                          |          |            |                           |                     |                                  |                   |                |                            |                            |                           |
| latissimum (Norman).....           | x                   | ..         | x                        | ..                        | ..                       | x x      | ..                  | x x                        | x x                  | ..                          | x x                      | x        | x x        | x x                       | x x                 | x x                              | x x               | x x x          | x                          | x                          |                           |
| nodosum, Brady.....                | ..                  | x          | ..                       | ..                        | ..                       | ..       | ..                  | x                          | x                    | ..                          | ..                       | x x      | ..         | ..                        | x                   | x                                | ..                | x              | ..                         | ..                         |                           |
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| : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | Drip Bridge, near Strirling.             |
| : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | Bridge of Allan.                         |
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| „ <i>Montrosiense</i> .....          | 205  | „ <i>impressa</i> .....            | 185  |
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| „ <i>nodosum</i> .....               | 203  | „ <i>multifora</i> .....           | 187  |
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| „ <i>compressa</i> .....             | 195  |                                    |      |
| „ <i>concentrica</i> .....           | 194  |                                    |      |
| „ <i>cornuta</i> .....               | 199  |                                    |      |
| „ <i>cuneata</i> .....               | 196  |                                    |      |
| „ <i>flavescens</i> .....            | 193  |                                    |      |

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| " <i>angusta</i> .....               | 132  | " <i>nitida</i> .....               | 191  |



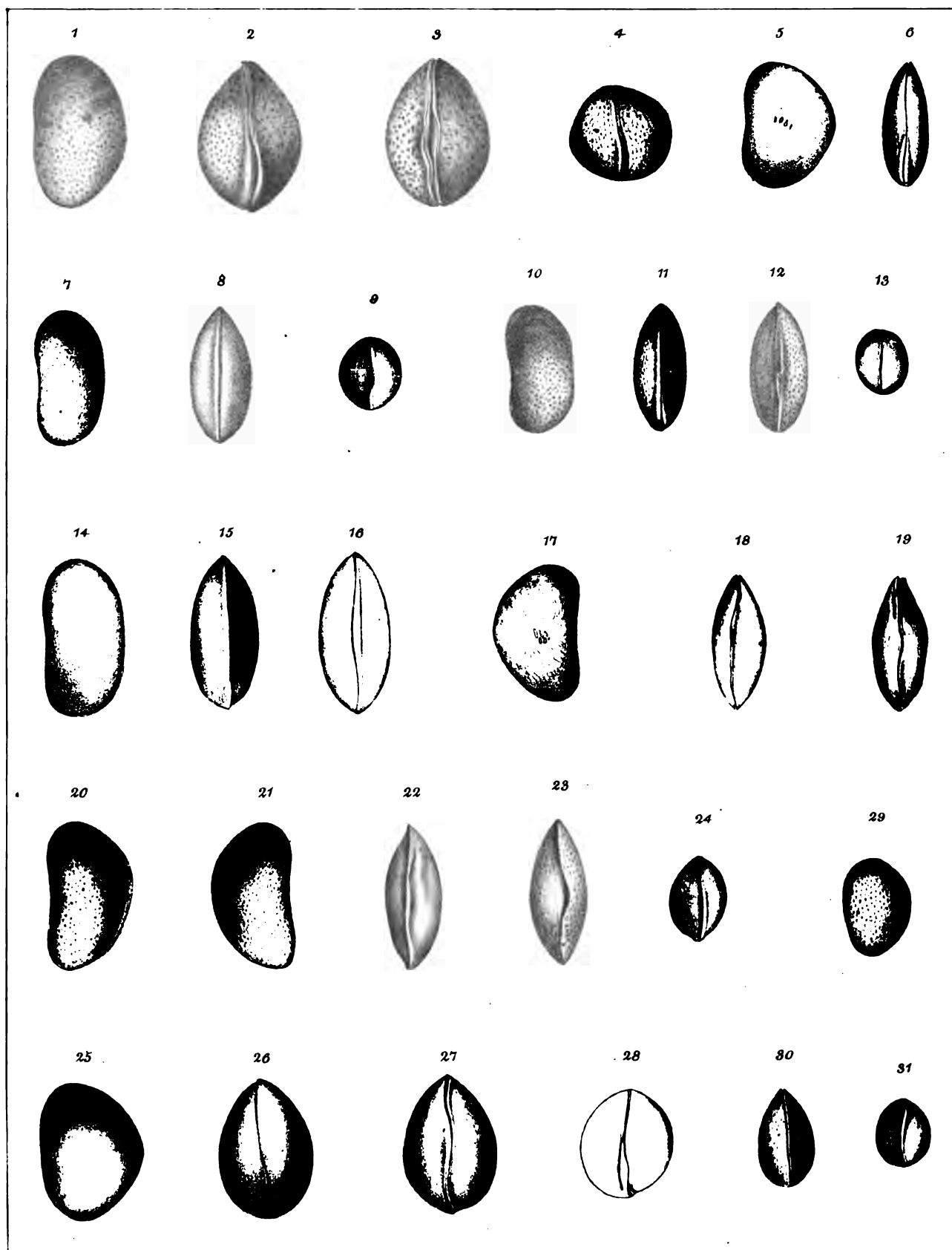
# PLATE I.

FIG.

|     |                             |                                 |   |                |
|-----|-----------------------------|---------------------------------|---|----------------|
| 1.  | <i>Cypridopsis obesa</i> .  | Carapace, seen from left side.  | } | (Hornsea.)     |
| 2.  | — —                         | " " above.                      |   |                |
| 3.  | — —                         | " " below.                      |   |                |
| 4.  | — —                         | " " front.                      |   |                |
| 5.  | <i>Cypris compressa</i> .   | Carapace, seen from left side.  | } | (Hornsea.)     |
| 6.  | — —                         | " " above.                      |   |                |
| 7.  | <i>Candona detecta</i> .    | Carapace, seen from left side.  | } | (Hornsea.)     |
| 8.  | — —                         | " " above.                      |   |                |
| 9.  | — —                         | " " front.                      |   |                |
| 10. | <i>Candona albicans</i> .   | Carapace, seen from left side.  | } | (Hornsea.)     |
| 11. | — —                         | " " above.                      |   |                |
| 12. | — —                         | " " below.                      |   |                |
| 13. | — —                         | " " front.                      |   |                |
| 14. | <i>Candona lactea</i> .     | Carapace, seen from left side.  | } | (Mersey beds.) |
| 15. | — —                         | " " above.                      |   |                |
| 16. | — —                         | " " below.                      |   |                |
| 17. | <i>Cypris salina</i> .      | Carapace, seen from right side. | } | (Crofthead.)   |
| 18. | — —                         | " " above.                      |   |                |
| 19. | — —                         | " " below.                      |   |                |
| 20. | <i>Potamocypris fulva</i> . | Carapace, seen from left side.  | } | (Dalmuir.)     |
| 21. | — —                         | Right valve, seen from outside. |   |                |
| 22. | — —                         | Carapace, seen from above.      |   |                |
| 23. | — —                         | " " below.                      |   |                |
| 24. | — —                         | " " front.                      |   |                |
| 25. | <i>Cypris laevis</i> .      | Carapace, seen from left side.  | } | (Whittlesea.)  |
| 26. | — —                         | " " above.                      |   |                |
| 27. | — —                         | " " below.                      |   |                |
| 28. | — —                         | " " front.                      |   |                |
| 29. | <i>Cypris ovum</i> .        | Carapace, seen from left side.  | } | (Hornsea.)     |
| 30. | — —                         | " " above.                      |   |                |
| 31. | — —                         | " " front.                      |   |                |

(All magnified 40 diameters.)

Post-Tertiary Entomostraca Pl. I.







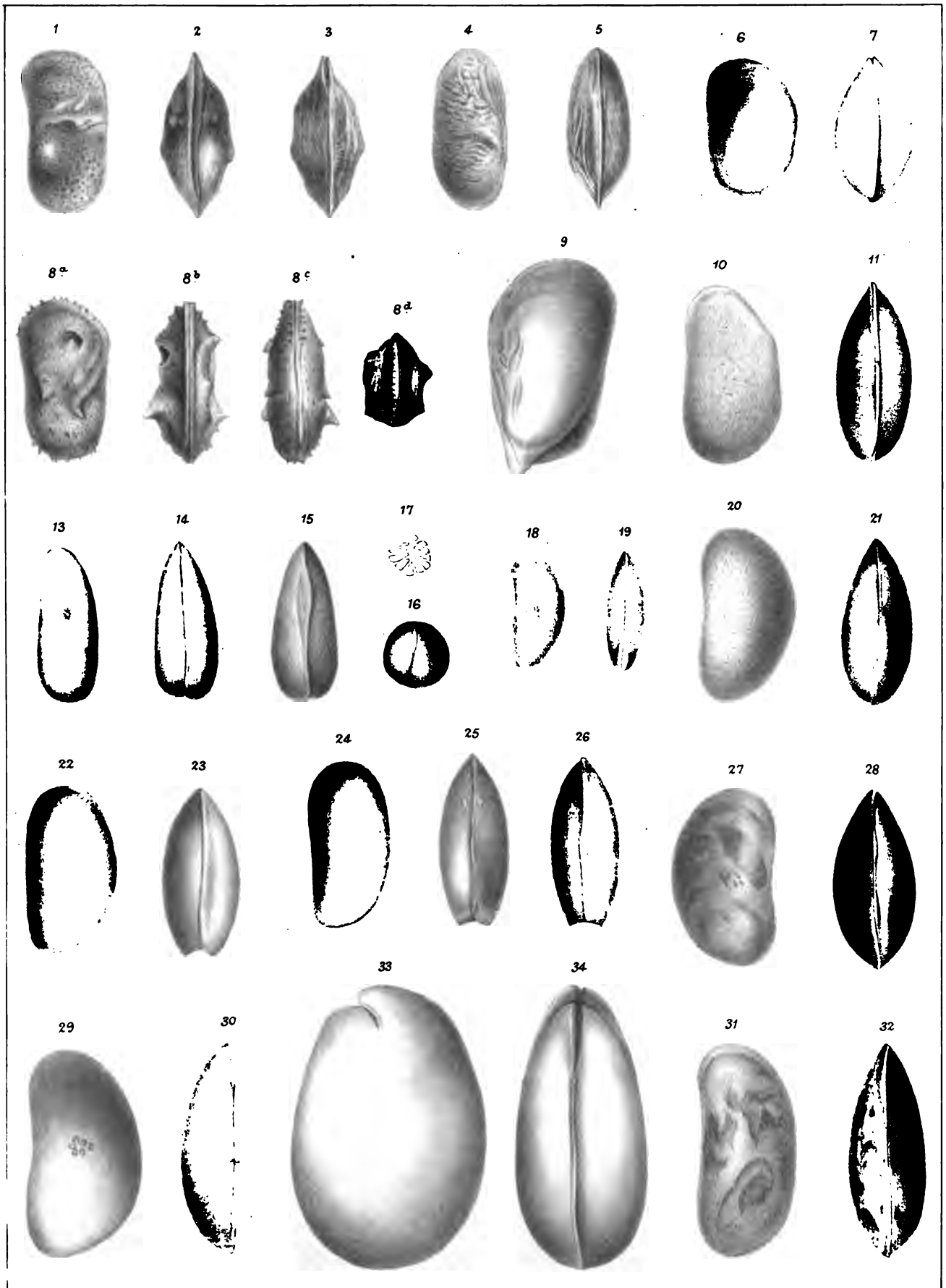


# PLATE II.

FIG.

|      |                                       |   |                              |
|------|---------------------------------------|---|------------------------------|
| 1.   | <i>Limnocythere Sancti-Patricii</i> . | Carapace, seen from left side.                      | } × 30 (Recent.)             |
| 2.   | —                                     | " " above   |                              |
| 3.   | —                                     | " " below.  |                              |
| 4.   | <i>Bythocythere elongata</i> .        | Carapace, seen from right side.                     | } × 60 (Girvan.)             |
| 5.   | —                                     | " " above.  |                              |
| 6.   | <i>Cypris cinerea</i> .               | Carapace (slightly imperfect), seen from left side. | } × 60 (Crofthead.)          |
| 7.   | "                                     | " " above.  |                              |
| 8 a. | <i>Limnocythere monstifica</i> .      | Carapace, seen from left side.                      | } × 40 (Recent.)             |
| 8 b. | —                                     | " " above.  |                              |
| 8 c. | —                                     | " " below.  |                              |
| 8 d. | —                                     | " " front.  |                              |
| 9.   | <i>Pseudocythere caudata</i> .        | Right valve, seen from outside.                     | × 85 (Dalmuir.)              |
| 10.  | <i>Candona compressa</i> .            | Carapace, seen from left side.                      | } × 40 (Recent.)             |
| 11.  | —                                     | " " above.  |                              |
| 13.  | <i>Darwinella Stevensoni</i> .        | Carapace, seen from left side (female).             | } × 40 (Recent.)             |
| 14.  | —                                     | " " above.  |                              |
| 15.  | —                                     | " " below.  |                              |
| 16.  | —                                     | " " front.  |                              |
| 17.  | —                                     | Lucid spots × 100.                                  |                              |
| 18.  | <i>Pontocypris acupunctata</i> .      | Carapace, seen from left side.                      | } × 40 (Recent.)             |
| 19.  | —                                     | " " above.  |                              |
| 20.  | <i>Cypridopsis Newtoni</i> .          | Carapace, seen from left side.                      | } × 40 (Recent.)             |
| 21.  | —                                     | " " above.  |                              |
| 22.  | <i>Krithe Bartonensis</i> .           | Carapace of female, seen from left side.            | } × 55 (Duntroon.)           |
| 23.  | —                                     | " " below.  |                              |
| 24.  | —                                     | Carapace of male, seen from left side.              |                              |
| 25.  | —                                     | " " above.  |                              |
| 26.  | —                                     | " " below.  |                              |
| 27.  | <i>Cypris virens</i> .                | Carapace, seen from right side.                     | } × 16 (Recent.)             |
| 28.  | —                                     | " " above.  |                              |
| 29.  | <i>Candona candida</i> .              | Left valve of male, seen from outside.              | } × 40 (Dalmuir, south bed.) |
| 30.  | —                                     | " " above.  |                              |
| 31.  | <i>Cypris reptans</i> .               | Carapace, seen from left side.                      | } × 16 (Recent.)             |
| 32.  | —                                     | " " above.  |                              |
| 33.  | <i>Asterope teres</i> .               | Carapace of female, seen from left side.            | } × 40 (Jordan Hill.)        |
| 34.  | —                                     | " " below.  |                              |

NOTE.—The figures of *Cypridopsis Newtoni*, *Candona compressa*, *Darwinella Stevensoni*, *Limnocythere monstifica*, *L. Sancti-Patricii*, *Pontocypris acupunctata*, *Cypris virens*, and *Cypris reptans*, are all taken from recent specimens, no fossil examples having been found sufficiently perfect to illustrate the species satisfactorily.



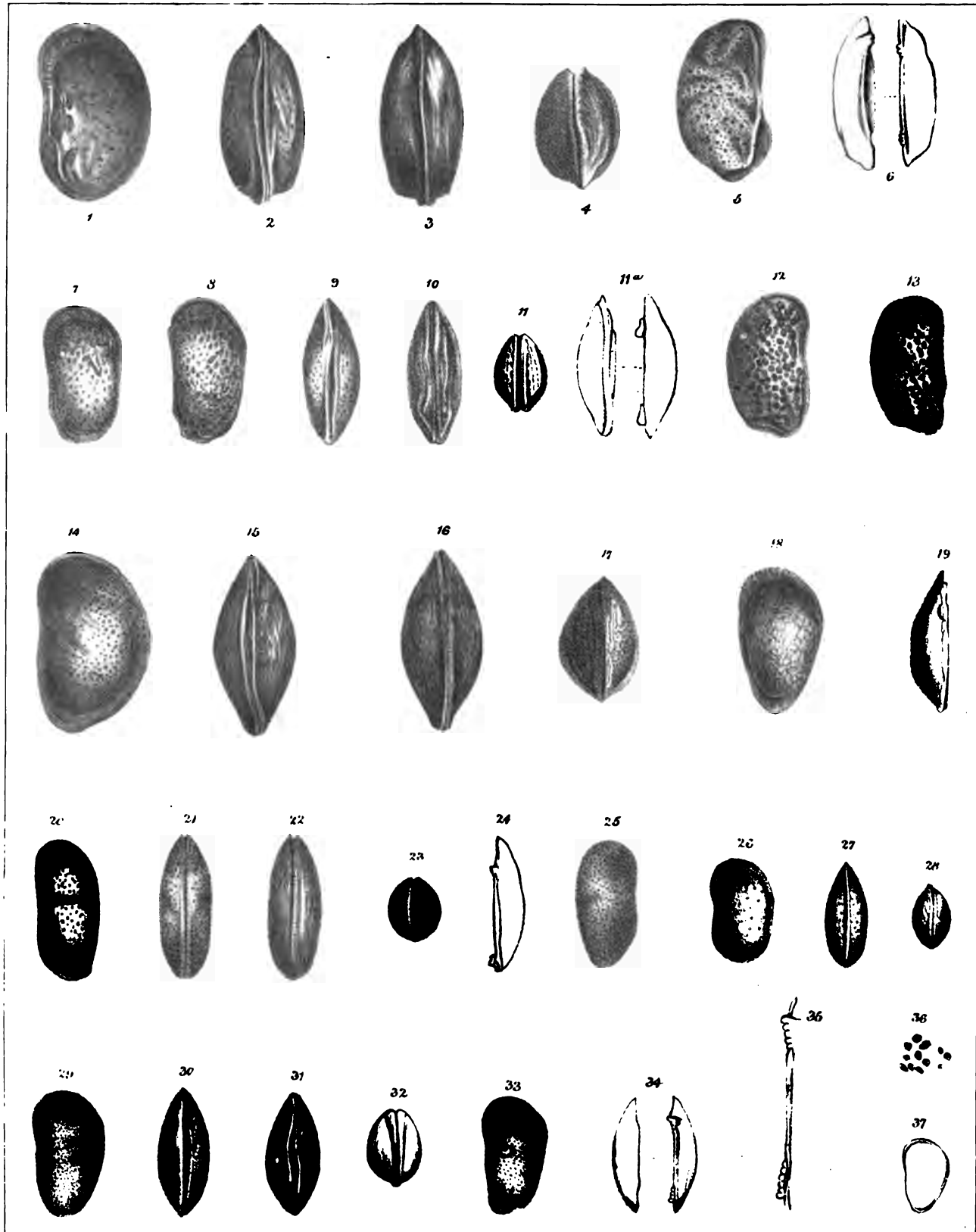




# PLATE III.

|       |                            |  |                                      |                   |                         |
|-------|----------------------------|--|--------------------------------------|-------------------|-------------------------|
| FIG.  |                            |  |                                      |                   |                         |
| 1.    | <i>Cythere lutea.</i>      | Carapace of female, seen from left side. |                                      |                   |                         |
| 2.    | —                          | —  | —                                    | above.            |                         |
| 3.    | —                          | —  | —                                    | below.            |                         |
| 4.    | —                          | —  | —                                    | front.            |                         |
| 5.    | —                          | Carapace of male,                        | —                                    | right side.       |                         |
| 6.    | —                          | —  | separated valves show-               |                   |                         |
|       |                            |  | ing hinge-margins.                   |                   | (Loch Gilp.)            |
| 7.    | <i>Cythere villosa.</i>    | Carapace of female, seen from left side. |                                      |                   |                         |
| 8.    | —                          | —  | male,                                | —                 |                         |
| 9.    | —                          | —  | —                                    | above.            |                         |
| 10.   | —                          | —  | —                                    | below.            |                         |
| 11.   | —                          | —  | —                                    | front.            |                         |
| 11 a. | —                          | —  | Separated valves.                    |                   |                         |
| 12.   | —                          | —  | —                                    | female (variety). |                         |
| 13.   | —                          | —  | Carapace of male, radiate variety.   |                   | (Greenock.)             |
| 14.   | <i>Cythere convexa.</i>    | Carapace of female, seen from left side. |                                      |                   |                         |
| 15.   | —                          | —  | —                                    | above.            |                         |
| 16.   | —                          | —  | —                                    | below.            |                         |
| 17.   | —                          | —  | —                                    | front.            |                         |
|       |                            |  |                                      |                   | (Oban, raised-beach.)   |
| 18.   | <i>Cythere Jeffreysii.</i> | Left valve, seen from outside.           |                                      |                   |                         |
| 19.   | —                          | —  | —                                    | above.            |                         |
|       |                            |  |                                      |                   | (Oban, raised-beach.)   |
| 20.   | <i>Cythere pellucida.</i>  | Carapace of female, seen from left side. |                                      |                   |                         |
| 21.   | —                          | —  | —                                    | above.            |                         |
| 22.   | —                          | —  | —                                    | below.            |                         |
| 23.   | —                          | —  | —                                    | front.            |                         |
| 24.   | —                          | —  | Right valve,                         | —                 |                         |
|       |                            |  |                                      | above.            | (Loch Gilp.)            |
| 25.   | <i>Cythere castanea.</i>   | Right valve of female.                   |                                      |                   | (Paisley, brick-field.) |
| 26.   | <i>Cythere viridis.</i>    | Carapace of female, seen from left side. |                                      |                   |                         |
| 27.   | —                          | —  | —                                    | above.            |                         |
| 28.   | —                          | —  | —                                    | front.            |                         |
|       |                            |  |                                      |                   | (Paisley.)              |
| 29.   | <i>Cythere pulchella.</i>  | Carapace of female, seen from left side. |                                      |                   |                         |
| 30.   | —                          | —  | —                                    | above.            |                         |
| 31.   | —                          | —  | —                                    | below.            |                         |
| 32.   | —                          | —  | —                                    | front.            |                         |
| 33.   | —                          | —  | Carapace of male,                    | —                 |                         |
| 34.   | —                          | —  | —                                    | left side.        |                         |
|       |                            |  | separated valves,                    |                   |                         |
|       |                            |  | seen from above.                     |                   |                         |
| 35.   | —                          | —  | Hinge-processes of right valve × 84. |                   |                         |
| 36.   | —                          | —  | Lucid spots × 84.                    |                   |                         |
| 37.   | —                          | —  | Outline of young carapace.           |                   |                         |
|       |                            |  |                                      |                   | (Jordan Hill.)          |

(All × 40 except where otherwise stated.)









# PLATE IV.

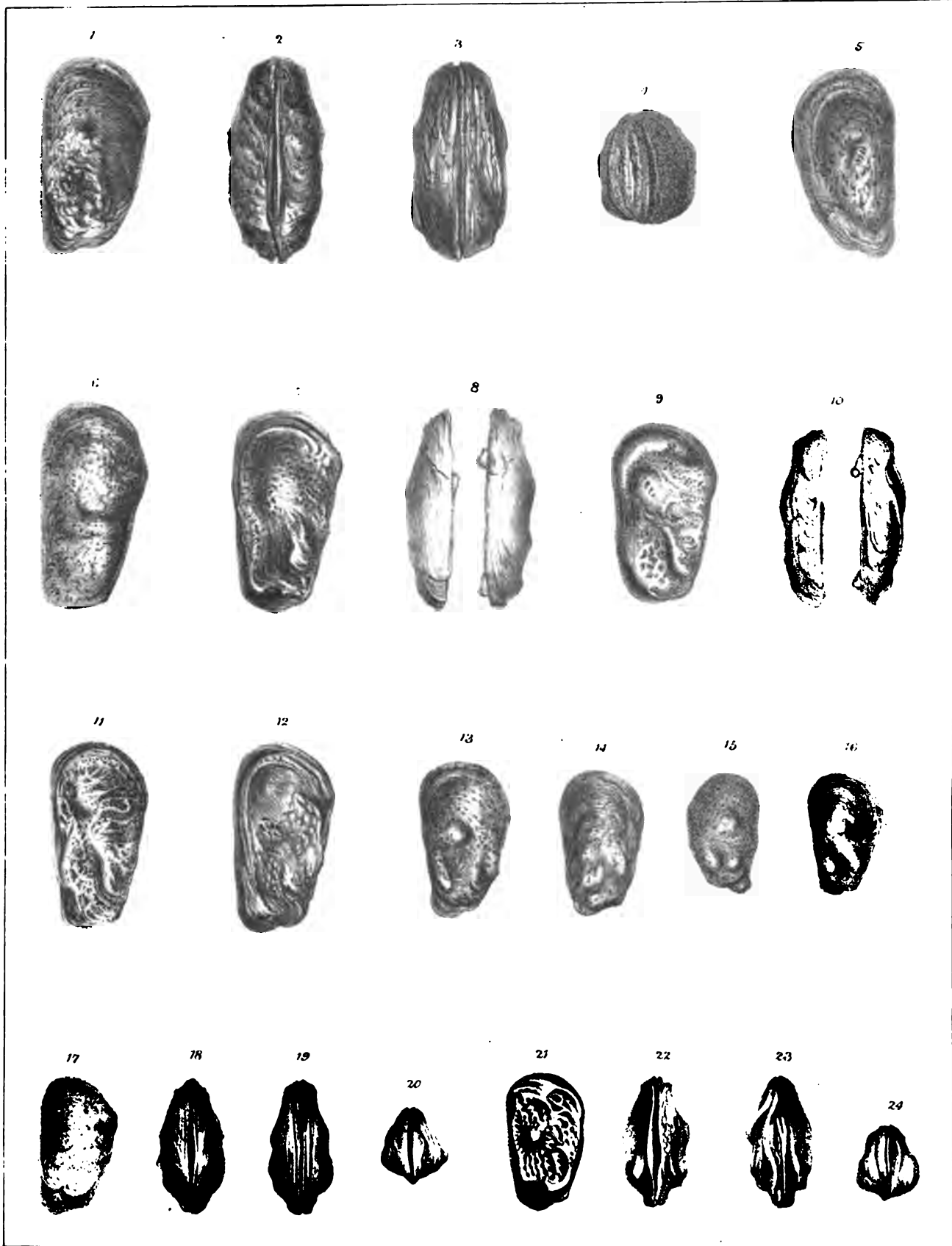
FIG.

- |        |  |  |
|--------|--|--|
| 1.     | <i>Cythere concinna</i> . <sup>1</sup> | Carapace of female (variety) seen from left side.  |
| 2.     | — —                                    | „ „ above.   |
| 3.     | — —                                    | „ „ below.   |
| 4.     | — —                                    | „ „ front.   |
| 5.     | — —                                    | Right valve of female carapace, seen from outside. |
| 6.     | — —                                    | Left valve of male carapace, seen from outside.    |
| 7.     | — —                                    | Carapace of male (variety), seen from left side.   |
| 8.     | — —                                    | „ valves separated and seen from above.            |
| 9.     | — —                                    | Carapace of female, seen from left side.           |
| 10.    | — —                                    | „ valves separated and seen from above.            |
| 11.    | — —                                    | Carapace, seen from left side, male ; normal form. |
| 12.    | — —                                    | „ „ „ variety.                                     |
| 13—16. | — —                                    | Carapace in different stages of growth.            |
| 17.    | — —                                    | Young carapace, seen from left side.               |
| 18.    | — —                                    | „ „ above.   |
| 19.    | — —                                    | „ „ below.   |
| 20.    | — —                                    | „ „ front.   |
| 21.    | <i>Cythere angulata</i> . <sup>2</sup> | Carapace of female, seen from left side.           |
| 22.    | — —                                    | „ „ above.   |
| 23.    | — —                                    | „ „ below.   |
| 24.    | — —                                    | „ „ front.   |

(All magnified 40 diameters.)

<sup>1</sup> At page 160, 1st line, *for* Figs. 1—16, *read* figs. 1—20.

<sup>2</sup> „ 162, 22nd „ *for* „ 17—24, *read* „ 21—24.







# PLATE V.

FIG.

|     |                             |   |  |         |   |                   |
|-----|-----------------------------|---|--|---------|---|-------------------|
| 1.  | <i>Cythere emarginata.</i>  | Carapace of male, seen from left side.    |  |         |   |                   |
| 2.  | —                           | —   | "                                      | "       | " | above.            |
| 3.  | —                           | —   | "                                      | "       | " | below.            |
| 4.  | —                           | —   | "                                      | "       | " | front.            |
| 5.  | —                           | —   | "                                      | female, | " | right side.       |
| 6.  | —                           | —   | "                                      | "       | " | separated valves. |
| 7.  | <i>Cythere tuberculata.</i> | Carapace of female, seen from left side.  |  |         |   |                   |
| 8.  | —                           | —   | "                                      | "       | " | above.            |
| 9.  | —                           | —   | "                                      | "       | " | below.            |
| 10. | —                           | —   | "                                      | "       | " | front.            |
| 11. | —                           | —   | "                                      | male,   | " | left side.        |
| 12. | —                           | —   | "                                      | "       | " | hinge-margins.    |
| 13. | <i>Cythere Dunelmensis.</i> | Left valve of male, lateral view.         |  |         |   |                   |
| 14. | —                           | —   | "                                      | "       | " | seen from above.  |
| 15. | —                           | —   | "                                      | "       | " | below.            |
| 16. | —                           | —   | "                                      | "       | " | front.            |
| 17. | —                           | —   | "                                      | "       | " | inside.           |
| 18. | —                           | —   | Right valve of female.                 |         |   |                   |
| 19. | —                           | —   | "                                      | young.  |   |                   |
| 20. | —                           | —   | Hinge-margins.                         |         |   |                   |
| 21. | <i>Cythere costata.</i>     | Right valve of female, seen from outside. |  |         |   |                   |
| 22. | —                           | —   | "                                      | "       | " | above.            |
| 23. | —                           | —   | Left valve of male, seen from outside. |         |   |                   |
| 24. | —                           | —   | "                                      | "       | " | inside.           |

(Loch Gilp.)

(Dalmuir.)

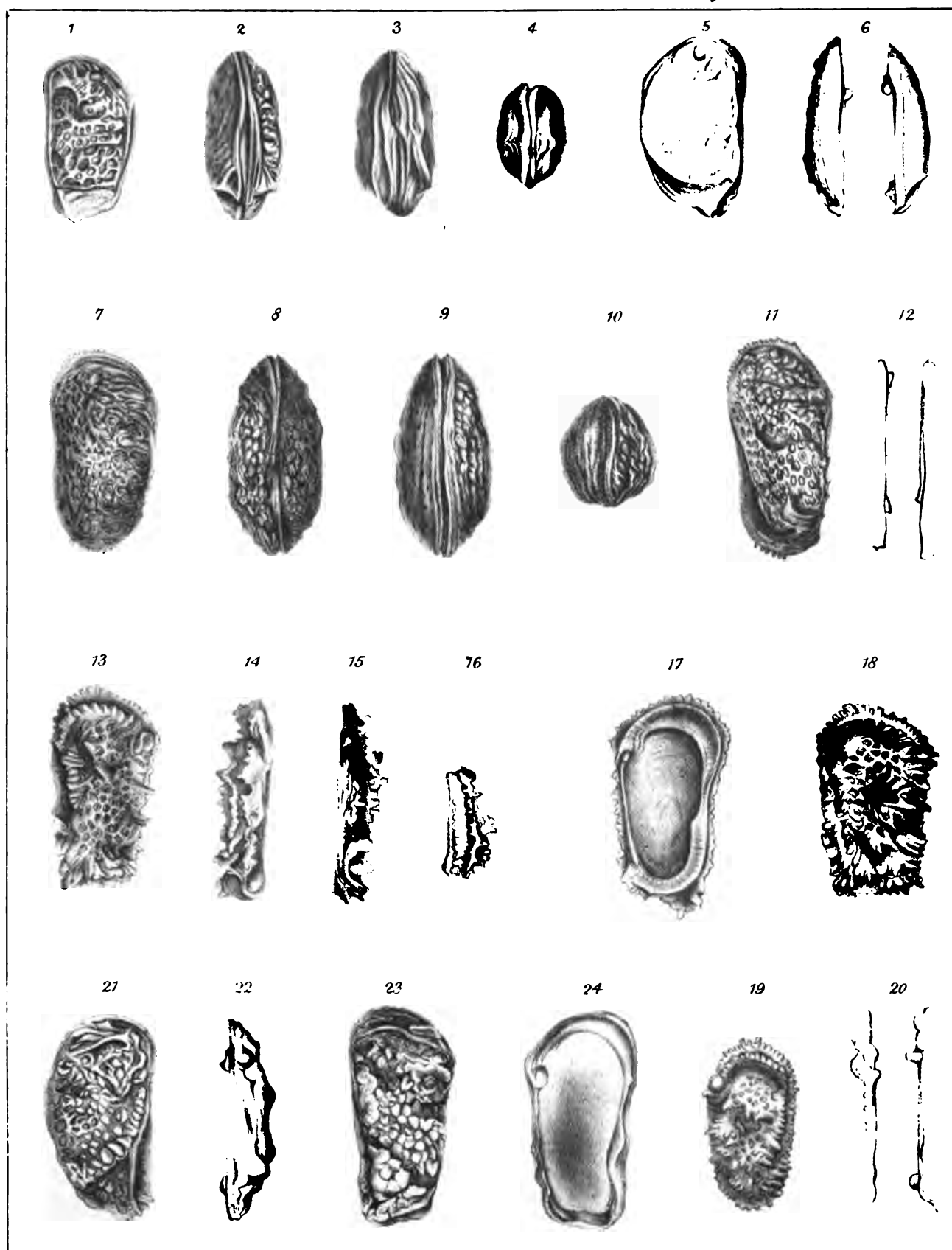
(Greenock new Dock.)

(Jordan Hill.)

(Bridlington.)

(Bridlington.)

(All magnified 40 diameters.)







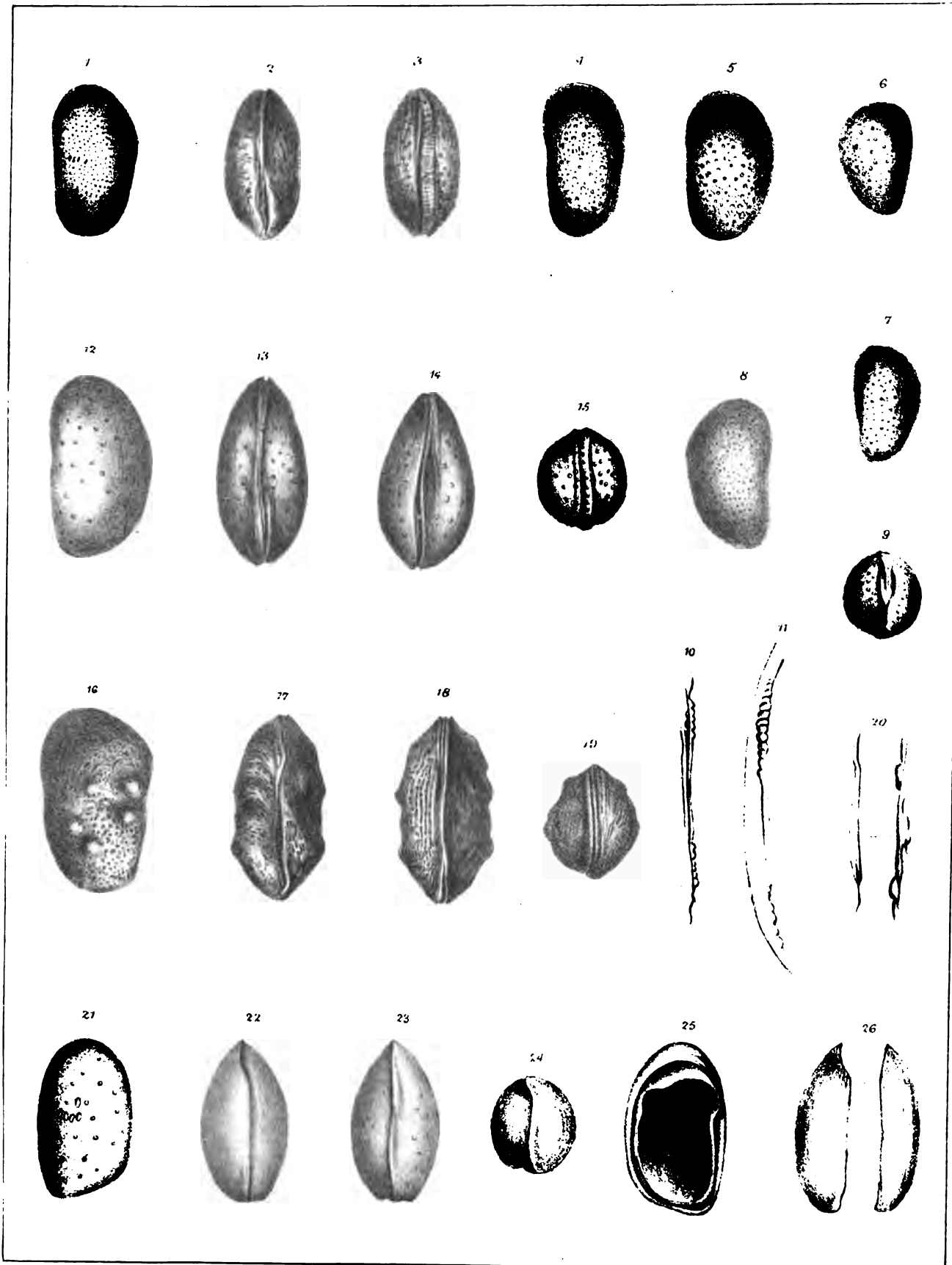


# PLATE VI.

## FIG.

1. *Cytheridea punctillata*. Carapace of female, seen from left side.
2. — — — — — " " above.
3. — — — — — " " below.
4. — — — — — Carapace of male, seen from left side.
5. — — — — — " female (variety).
- 6, 7. — — — — — Carapaces in early stages of growth.
8. — — — — — Right valve, seen from outside.
9. — — — — — End-view of adult carapace.
10. — — — — — Hinge-margin of left valve, seen from above.
11. — — — — — " " " inside.
12. *Cytheridea papillosa*. Carapace of female, seen from left side.
13. — — — — — " " above.
14. — — — — — " " below.
15. — — — — — " " front.
16. *Cytheridea lacustris*. Carapace, seen from left side.
17. — — — — — " " above.
18. — — — — — " " below.
19. — — — — — " " front.
20. — — — — — Hinge-margins, seen from above.
21. *Krithe glacialis*. Carapace, seen from left side.
22. — — — — — " " above.
23. — — — — — " " below.
24. — — — — — " " front.
25. — — — — — Left valve, seen from inside.
26. — — — — — Right and left valves, separated, and seen from above.

(All magnified 40 diameters, except 10, 11, and 20, which are on a larger scale.)





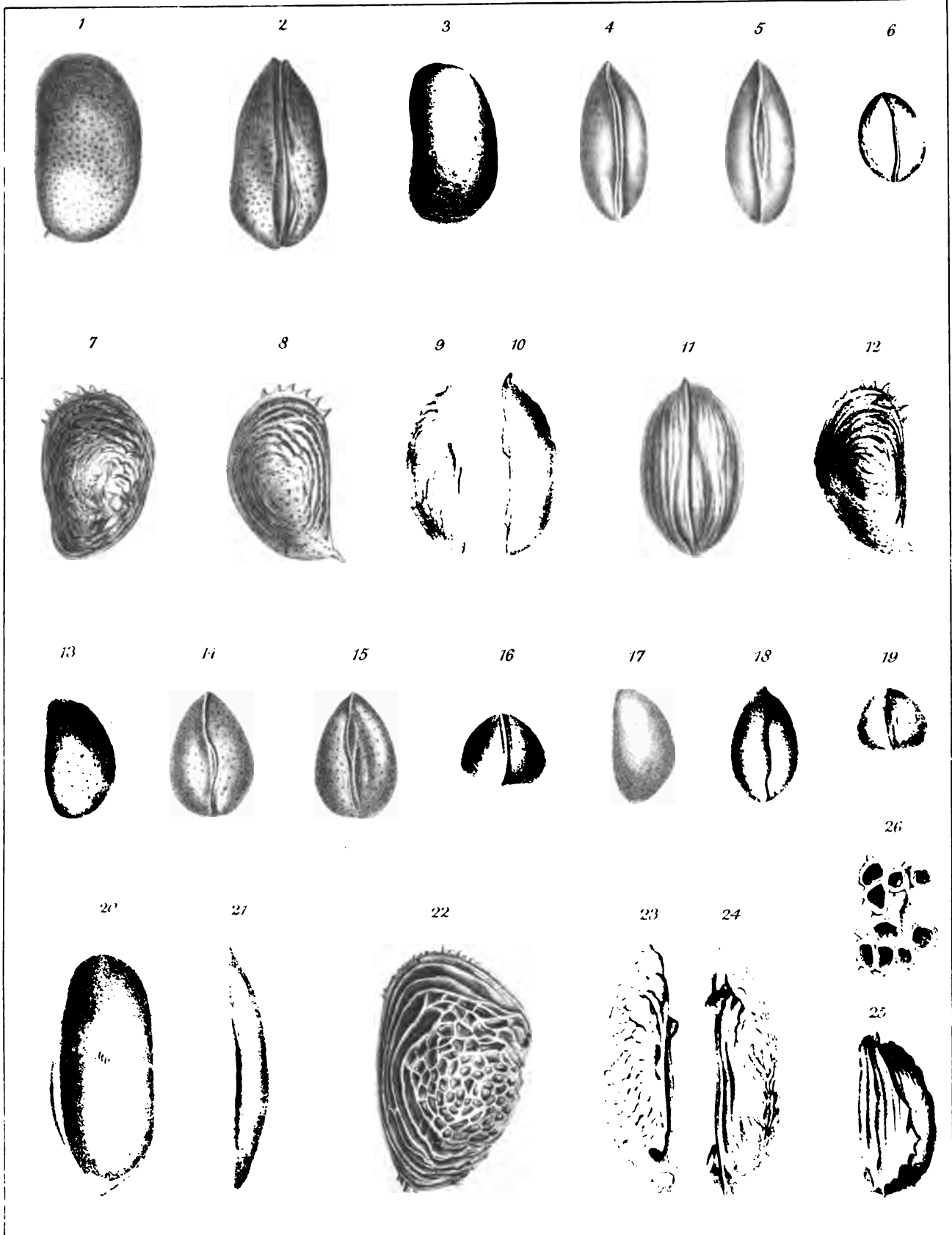


# PLATE VII.

FIG.

|     |  |  |   |              |
|-----|--|--|---|--------------|
| 1.  | <i>Cytheridea torosa</i> , var. <i>teres</i> . | Carapace of female, seen from left side. | } | (Paisley.)   |
| 2.  | — —  | „ „ above.                               |   |              |
| 3.  | <i>Cytheridea</i> (?) <i>inornata</i> .        | Carapace, seen from left side.           | } | (Annochie.)  |
| 4.  | — —  | „ „ above.                               |   |              |
| 5.  | — —  | „ „ below.                               |   |              |
| 6.  | — —  | „ „ front.                               |   |              |
| 7.  | <i>Cytheridea Sorbyana</i> .                   | Left valve of female, seen from side.    | } | (Errol.)     |
| 8.  | — —  | Right „ „ „                              |   |              |
| 9.  | — —  | Left „ „ above.                          |   |              |
| 10. | — —  | Right „ „ „                              |   |              |
| 11. | — —  | Carapace of female, seen from below.     | } | (Norway.)    |
| 12. | — —  | Right valve of male, seen from side.     |   |              |
| 13. | <i>Xestoleberis depressa</i> .                 | Carapace of female, seen from left side. | } | (Loch Gilp.) |
| 14. | — —  | „ „ above.                               |   |              |
| 15. | — —  | „ „ below.                               |   |              |
| 16. | — —  | „ „ front.                               |   |              |
| 17. | — —  | Carapace of male, „ left side.           |   |              |
| 18. | — —  | „ „ above.                               |   |              |
| 19. | — —  | „ „ front.                               |   |              |
| 20. | <i>Bythocythere simplex</i> .                  | Left valve of ? , seen from side.        | } | (Paisley.)   |
| 21. | — —  | „ „ above.                               |   |              |
| 22. | <i>Cythere mirabilis</i> (female).             | Left valve, seen from side.              | } | (Errol.)     |
| 23. | — — —  | „ „ above.                               |   |              |
| 24. | — — —  | Right valve „ „                          |   |              |
| 25. | — — —  | Left valve „ front.                      |   |              |
| 26. | — — —  | Lucid spots.                             |   |              |

(All the figures  $\times 40$ , except fig. 26, which is  $\times 96$ .)







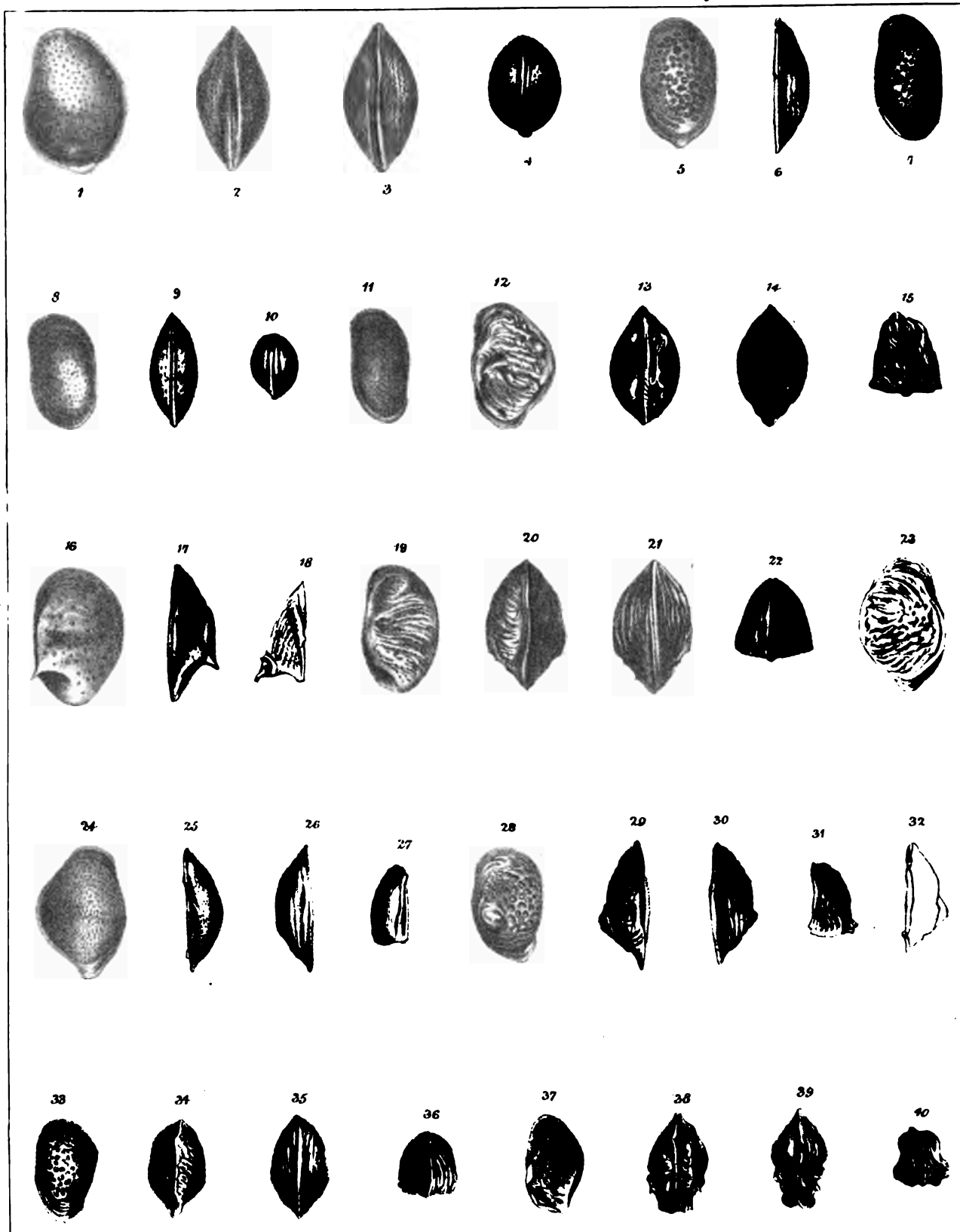


# PLATE VIII.

FIG.

- |     |                                    |  |                            |
|-----|------------------------------------|--|----------------------------|
| 1.  | <i>Loxoconcha impressa.</i>        | Carapace of female, seen from left side. | } (Oban, Raised-beach.)    |
| 2.  | —                                  | —  |                            |
| 3.  | —                                  | —  |                            |
| 4.  | —                                  | —  |                            |
| 5.  | <i>Loxoconcha guttata.</i>         | Left valve of female, seen from side.    | } (Drip Bridge, Stirling.) |
| 6.  | —                                  | —  |                            |
| 7.  | —                                  | —  |                            |
| 8.  | <i>Loxoconcha tamarindus.</i>      | Carapace of female, seen from left side. |                            |
| 9.  | —                                  | —  | } (Dalmuir.)               |
| 10. | —                                  | —  |                            |
| 11. | —                                  | —  |                            |
| 12. | <i>Cytheropteron nodosum.</i>      | Carapace, seen from left side.           |                            |
| 13. | —                                  | —  | } (Dumbarton.)             |
| 14. | —                                  | —  |                            |
| 15. | —                                  | —  |                            |
| 16. | <i>Cytheropteron arcuatum.</i>     | Left valve, seen from side.              |                            |
| 17. | —                                  | —  | } (Errol.)                 |
| 18. | —                                  | —  |                            |
| 19. | <i>Cytheropteron latissimum.</i>   | Carapace of male, seen from left side.   |                            |
| 20. | —                                  | —  |                            |
| 21. | —                                  | —  | } (Kilchattan.)            |
| 22. | —                                  | —  |                            |
| 23. | —                                  | —  |                            |
| 24. | <i>Cytheropteron inflatum.</i>     | Right valve, seen from side.             |                            |
| 25. | —                                  | —  | } (Errol.)                 |
| 26. | —                                  | —  |                            |
| 27. | —                                  | —  |                            |
| 28. | <i>Cytheropteron Montrosiense.</i> | Left valve of female, seen from outside. |                            |
| 29. | —                                  | —  | } (Montrose.)              |
| 30. | —                                  | —  |                            |
| 31. | —                                  | —  |                            |
| 32. | —                                  | —  |                            |
| 33. | —                                  | —  | } (Annochie Brick-works.)  |
| 34. | —                                  | —  |                            |
| 35. | —                                  | —  |                            |
| 36. | —                                  | —  |                            |
| 37. | <i>Cytheropteron angulatum.</i>    | Carapace, seen from left side.           | } (Dumbarton.)             |
| 38. | —                                  | —  |                            |
| 39. | —                                  | —  |                            |
| 40. | —                                  | —  |                            |

(All  $\times 40$ , except *C. arcuatum*, which is  $\times 50$ .)







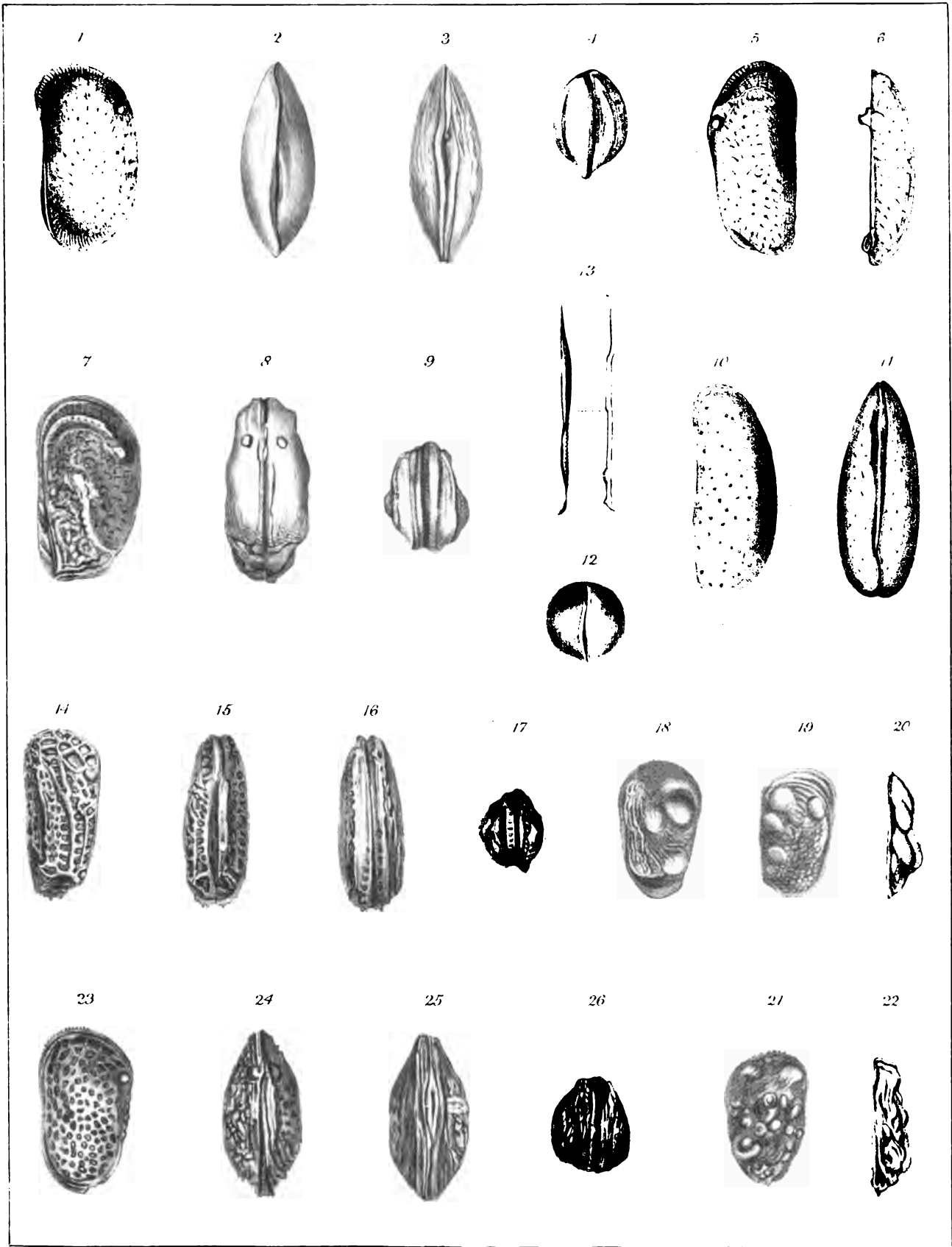
# PLATE IX.

FIG.

- |     |                              |  |                           |
|-----|------------------------------|--|---------------------------|
| 1.  | <i>Cythere albomaculata.</i> | Carapace of female, seen from left side.     | } (Raised beach, Irvine.) |
| 2.  | — —                          | " " above.                                   |                           |
| 3.  | — —                          | " " below.                                   |                           |
| 4.  | — —                          | " " front.                                   |                           |
| 5.  | <i>Cythere leioderma.</i>    | Right valve, seen from outside.              | } (Bridlington.)          |
| 6.  | — —                          | " " above.                                   |                           |
| 7.  | <i>Cythere concinna.</i>     | Carapace of female, seen from left side.     | } (Bridlington.)          |
| 8.  | — —                          | " " above.                                   |                           |
| 9.  | — —                          | " " front.                                   |                           |
| 10. | <i>Cytheridea elongata.</i>  | Carapace, seen from left side.               | } (Raised beach, Irvine.) |
| 11. | — —                          | " " above.                                   |                           |
| 12. | — —                          | " " behind.                                  |                           |
| 13. | — —                          | Hinge-margins.                               |                           |
| 14. | <i>Cythere emaciata.</i>     | Carapace of male, seen from left side.       | } (Raised beach, Oban.)   |
| 15. | — —                          | " " above.                                   |                           |
| 16. | — —                          | " " below.                                   |                           |
| 17. | — —                          | " " front.                                   |                           |
| 18. | <i>Cythere globulifera.</i>  | Left valve (of male?), seen from outside.    | } (Errol.)                |
| 19. | — —                          | Right valve (of female?), seen from outside. |                           |
| 20. | — —                          | " " above.                                   | } × 50 (Annochie.)        |
| 21. | — —                          | Right valve, seen from outside.              |                           |
| 22. | — —                          | " " above.                                   |                           |
| 23. | <i>Cythere laticarina.</i>   | Carapace, seen from the left side.           | } (Raised beach, Oban.)   |
| 24. | — —                          | " " above.                                   |                           |
| 25. | — —                          | " " below.                                   |                           |
| 26. | — —                          | " " front.                                   |                           |

(All × 40, except where otherwise stated.)

Post-Tertiary Entomostraca Pl. IX.







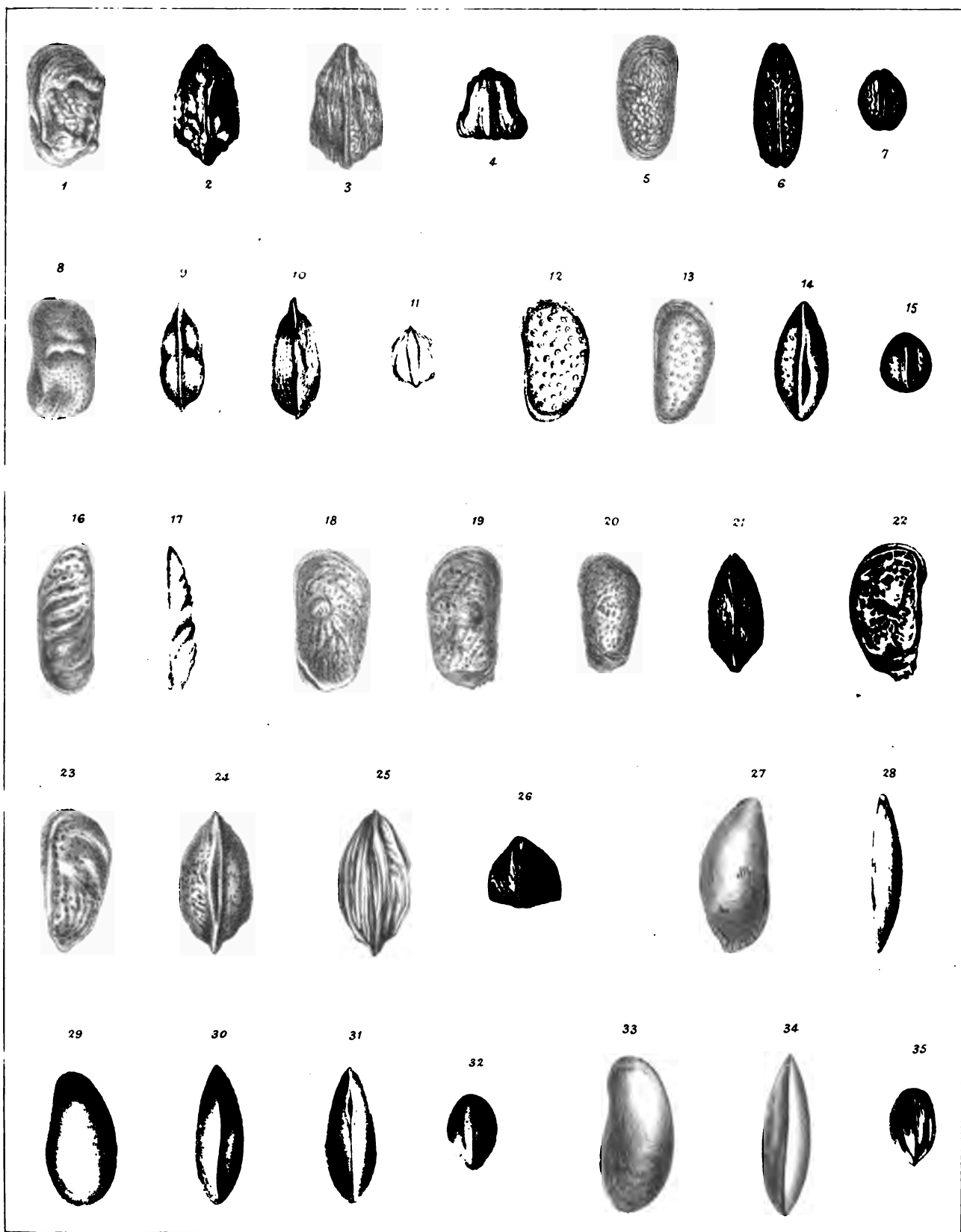


# PLATE X.

|      |                                 |  |   |          |             |                                |
|------|---------------------------------|--|---|----------|-------------|--------------------------------|
| FIG. |                                 |  |   |          |             |                                |
| 1.   | <i>Cythere limicola.</i>        | Carapace of female, seen from left side. |   |          |             |                                |
| 2.   | —                               | —  | " | "        | above.      | } (Kilchattan.)                |
| 3.   | —                               | —  | " | "        | below.      |                                |
| 4.   | —                               | —  | " | "        | front.      |                                |
| 5.   | <i>Cythere cribrosa.</i>        | Carapace, seen from right side.          |   |          |             |                                |
| 6.   | —                               | —  | " | "        | above.      | } (Bridlington.)               |
| 7.   | —                               | —  | " | "        | front.      |                                |
| 8.   | <i>Limnocythere inopinata.</i>  | Carapace, seen from left side.           |   |          |             |                                |
| 9.   | —                               | —  | " | "        | above.      | } (Hornsea.)                   |
| 10.  | —                               | —  | " | "        | below.      |                                |
| 11.  | —                               | —  | " | "        | front.      |                                |
| 12.  | <i>Fucythere Argus.</i>         | Carapace of female, seen from left side. |   |          |             |                                |
| 13.  | —                               | —  | " | male,    | "           | } (Dumbarton.)                 |
| 14.  | —                               | —  | " | "        | above.      |                                |
| 15.  | —                               | —  | " | "        | front.      |                                |
| 16.  | <i>Cytherideis subspiralis.</i> | Right valve, seen from outside.          |   |          |             | } (Burn of Haster, Caithness.) |
| 17.  | —                               | —  | " | "        | above.      |                                |
| 18.  | <i>Cythere Finmarchica.</i>     | Carapace, seen from left side.           |   |          |             | (Loch Gilp.)                   |
| 19.  | —                               | —  | " | "        | right side. | (Burn of Haster.)              |
| 20.  | —                               | —  | " | (young), | left side.  | } (Gamrie.)                    |
| 21.  | —                               | —  | " | "        | above.      |                                |
| 22.  | <i>Cythere angulata</i> , var.  | Carapace, seen from right side.          |   |          |             | (Dalmuir.)                     |
| 23.  | <i>Cythere cuneiformis.</i>     | Carapace of female, seen from left side. |   |          |             |                                |
| 24.  | —                               | —  | " | "        | above.      | } (Bridge of Allan.)           |
| 25.  | —                               | —  | " | "        | below.      |                                |
| 26.  | —                               | —  | " | "        | front.      |                                |
| 27.  | <i>Paradoxostoma ensiforme.</i> | Right valve, from outside.               |   |          |             |                                |
| 28.  | —                               | —  | " | "        | above.      | } (Bridlington.)               |
| 29.  | <i>Paradoxostoma variabile.</i> | Carapace, seen from left side.           |   |          |             |                                |
| 30.  | —                               | —  | " | "        | above.      | } (Cumbrae, College-bed.)      |
| 31.  | —                               | —  | " | "        | below.      |                                |
| 32.  | —                               | —  | " | "        | front.      |                                |
| 33.  | <i>Sclerochilus contortus.</i>  | Carapace, seen from left side.           |   |          |             |                                |
| 34.  | —                               | —  | " | "        | below.      | } (Cumbrae, College-bed.)      |
| 35.  | —                               | —  | " | "        | front.      |                                |

(All magnified 40 diameters.)

Post-Tertiary Entomostraca Pl. X.







# PLATE XI.

|      |  |  |                             |                  |                  |
|------|--|--|-----------------------------|------------------|------------------|
| FIG. |  |  |                             |                  |                  |
| 1.   | <i>Cytherura clathrata</i> .             | Carapace, seen from left side.           |                             |                  |                  |
| 2.   | —  | —  | "                           | "                | above.           |
| 3.   | —  | —  | "                           | "                | below.           |
| 4.   | —  | —  | "                           | "                | front.           |
| 5.   | <i>Cytherura cellulosa</i> .             | Carapace of male, seen from left side.   |                             |                  |                  |
| 6.   | —  | —  | "                           | "                | above.           |
| 7.   | <i>Cytherura concentrica</i> .           | Right valve, seen from side.             |                             |                  |                  |
| 8.   | —  | —  | "                           | "                | above.           |
| 9.   | <i>Cytherura undata</i> .                | Carapace of female, seen from left side. |                             |                  |                  |
| 10.  | —  | —  | "                           | "                | above.           |
| 11.  | —  | —  | "                           | "                | below.           |
| 12.  | —  | —  | Carapace of male (variety). |                  |                  |
| 13.  | —  | —  | "                           | seen from above. |                  |
| 14.  | —  | —  | "                           | "                | below.           |
| 15.  | —  | —  | "                           | "                | front.           |
| 16.  | <i>Cytherura similis</i> .               | Carapace, seen from left side.           |                             |                  |                  |
| 17.  | —  | —  | "                           | "                | below.           |
| 18.  | —  | —  | "                           | "                | front.           |
| 19.  | <i>Cytherura</i> (?) <i>complanata</i> . | Right valve, seen from side.             |                             |                  |                  |
| 20.  | —  | —  | "                           | "                | above.           |
| 21.  | <i>Cytherura compressa</i> .             | Carapace, seen from left side.           |                             |                  |                  |
| 22.  | —  | —  | "                           | "                | above.           |
| 23.  | —  | —  | "                           | "                | front.           |
| 24.  | <i>Cytherura Sarsii</i> .                | Carapace, seen from left side.           |                             |                  |                  |
| 25.  | —  | —  | "                           | "                | above.           |
| 26.  | —  | —  | "                           | "                | below.           |
| 27.  | —  | —  | "                           | "                | front.           |
| 28.  | <i>Cytherura nigrescens</i> .            | Carapace, seen from left side.           |                             |                  |                  |
| 29.  | —  | —  | "                           | "                | above.           |
| 30.  | —  | —  | "                           | "                | below.           |
| 31.  | —  | —  | "                           | "                | front.           |
| 32.  | —  | —  | "                           | "                | separate valves. |
| 33.  | <i>Cytherura pumila</i> .                | Carapace of female, seen from left side. |                             |                  |                  |
| 34.  | —  | —  | "                           | "                | above.           |
| 35.  | —  | —  | Carapace of male,           | "                | left side.       |
| 36.  | <i>Cythere Dunelmensis</i> (young).      | Left valve, lateral view.                |                             |                  |                  |
| 37.  | —  | —  | "                           | "                | seen from above. |
| 38.  | <i>Cytherura striata</i> .               | Carapace, seen from left side.           |                             |                  |                  |
| 39.  | —  | —  | "                           | "                | above.           |
| 40.  | —  | —  | "                           | "                | below.           |
| 41.  | —  | —  | "                           | "                | front.           |
| 42.  | <i>Cytherura cuneata</i> .               | Carapace of male, seen from left side.   |                             |                  |                  |
| 43.  | <i>Cytherura flavescens</i> .            | Carapace, seen from left side.           |                             |                  |                  |
| 44.  | —  | —  | "                           | "                | above.           |
| 45.  | —  | —  | "                           | "                | below.           |
| 46.  | —  | —  | "                           | "                | front.           |
| 47.  | —  | <i>cuneata</i> .                         | Sculpture of male carapace. |                  |                  |
| 48.  | <i>Cytherura angulata</i> .              | Carapace, seen from left side.           |                             |                  |                  |
| 49.  | —  | —  | "                           | "                | above.           |
| 50.  | —  | —  | "                           | "                | below.           |
| 51.  | —  | —  | "                           | "                | front.           |
| 52.  | <i>Cythere crispata</i> . <sup>1</sup>   | Carapace of female, seen from left side. |                             |                  |                  |
| 53.  | —  | —  | "                           | "                | above.           |
| 54.  | <i>Aglaia</i> (?) <i>glacialis</i> .     | Carapace, seen from left side.           |                             |                  |                  |
| 55.  | —  | —  | "                           | "                | above.           |
| 56.  | —  | —  | "                           | "                | front.           |

× 40 (Raised beach, Oban.)

× 84 (Gamrie.)

× 40 (Errol.)

× 40 (Paisley.)

× 40 (Loch Gilp.)

× 40 (Loch Gilp.)

× 50 (Annochie.)

× 40 (Gamrie.)

× 40 (College-bed, Cumbrae.)

× 40 (Jordan Hill.)

× 40 (Greenock Dock.)

× 40 (Errol.)

× 40 (College-bed, Cumbrae.)

× 40 (Dalmuir.)

× 40

× 84

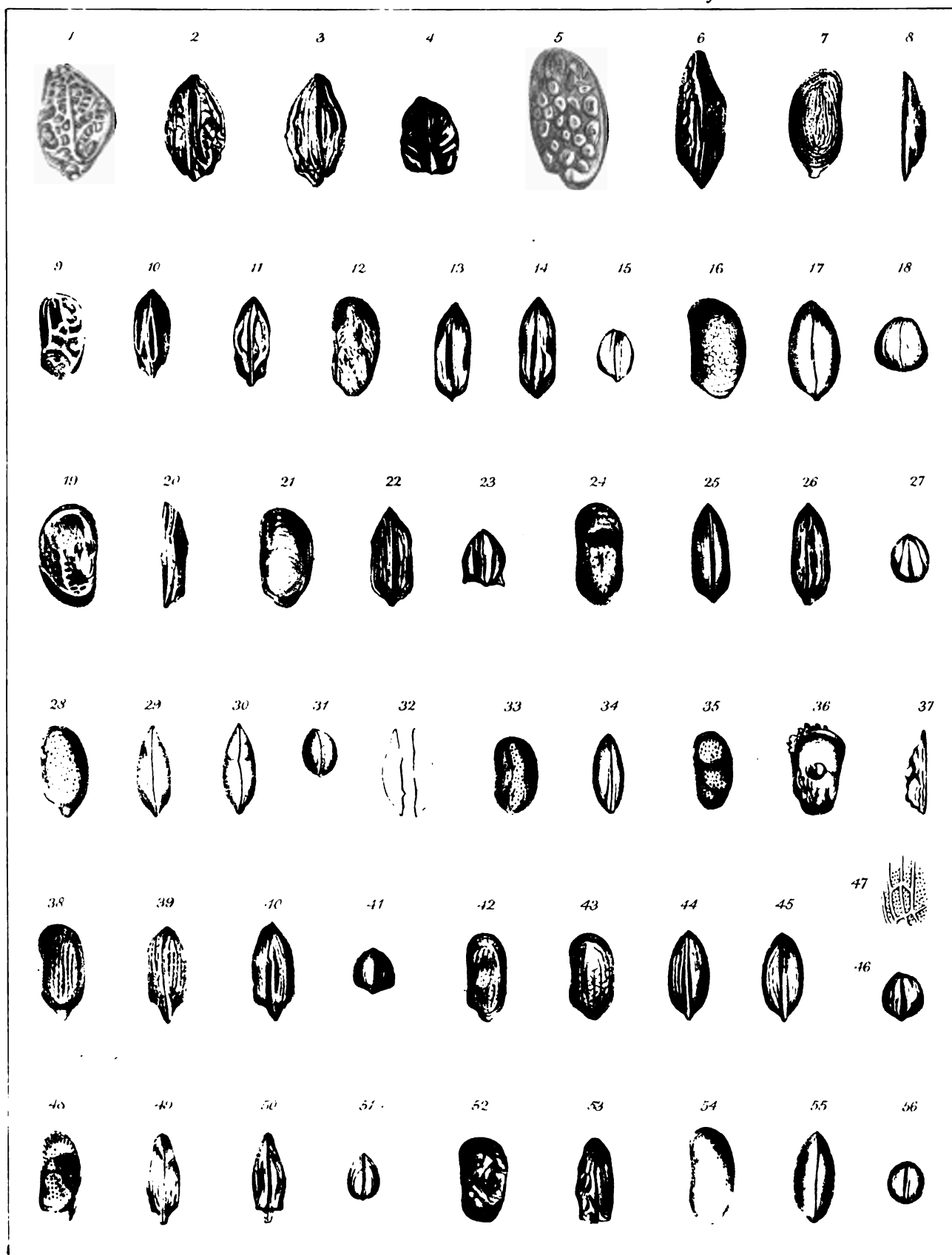
× 40 (Oban, raised beach.)

× 40 (Oban.)

(Drip Bridge.)

<sup>1</sup> At page 146, printed Plate X in error.

Post-Tertiary Entomostraca Pl. XI.





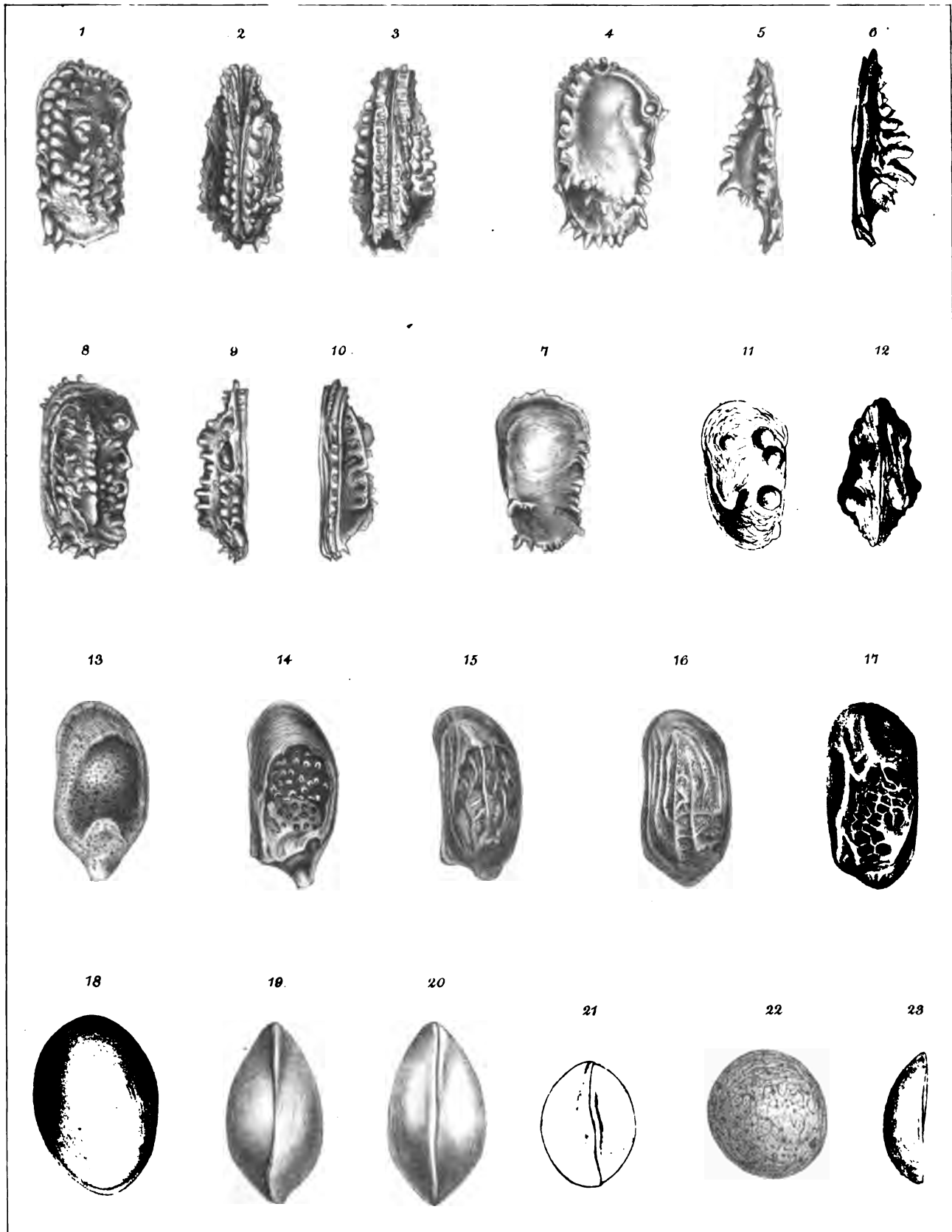




# PLATE XII.

FIG.

- |     |                               |   |   |                             |
|-----|-------------------------------|---|---|-----------------------------|
| 1.  | <i>Cythere Whiteii.</i>       | Carapace, seen from left side.                          | } | × 40<br>(Belfast New Dock.) |
| 2.  | — —                           | " " above.  |   |                             |
| 3.  | — —                           | " " below.  |   |                             |
| 4.  | <i>Cythere Jonesii.</i>       | Left valve, seen from outside.                          | } | × 40<br>(Belfast New Dock.) |
| 5.  | — —                           | " " above.  |   |                             |
| 6.  | — —                           | " " below.  |   |                             |
| 7.  | — —                           | var. <i>ceratoptera.</i> Left valve, seen from outside. |   |                             |
| 8.  | <i>Cythere antiquata.</i>     | Left valve, seen from outside.                          | } | × 40<br>(Belfast New Dock.) |
| 9.  | — —                           | " " above.  |   |                             |
| 10. | — —                           | " " below.  |   |                             |
| 11. | <i>Cythere globulifera.</i>   | Carapace, seen from left side.                          | } | × 60 (Barrie.)              |
| 12. | — —                           | " " above.  |   |                             |
| 13. | <i>Cytherura nigrescens.</i>  | Carapace of female, seen from left side.                |   | × 84 (Irvine.)              |
| 14. | <i>Cytherura angulata.</i>    | Carapace, seen from left side.                          |   | × 84 (Oban.)                |
| 15. | <i>Cytherura cuneata.</i>     | Carapace of male, seen from left side.                  | } | × 84 (Loch Gilp.)           |
|     |                               | side.   |   |                             |
| 16. | <i>Cytherura (similis?)</i>   | Carapace, seen from left side.                          |   | × 84 (Loch Gilp.)           |
| 17. | <i>Cytherura undata.</i>      | Carapace of male, seen from left side.                  |   | × 84 (Paisley.)             |
| 18. | <i>Bosquetia robusta.</i>     | Carapace, seen from left side.                          | } | × 40 (Paisley.)             |
| 19. | — —                           | " " above.  |   |                             |
| 20. | — —                           | " " below.  |   |                             |
| 21. | — —                           | " " front.  |   |                             |
| 22. | <i>Polycoppe orbicularis.</i> | Left valve, seen from outside.                          | } | × 60 (Dalmuir.)             |
| 23. | — —                           | " " above.  |   |                             |







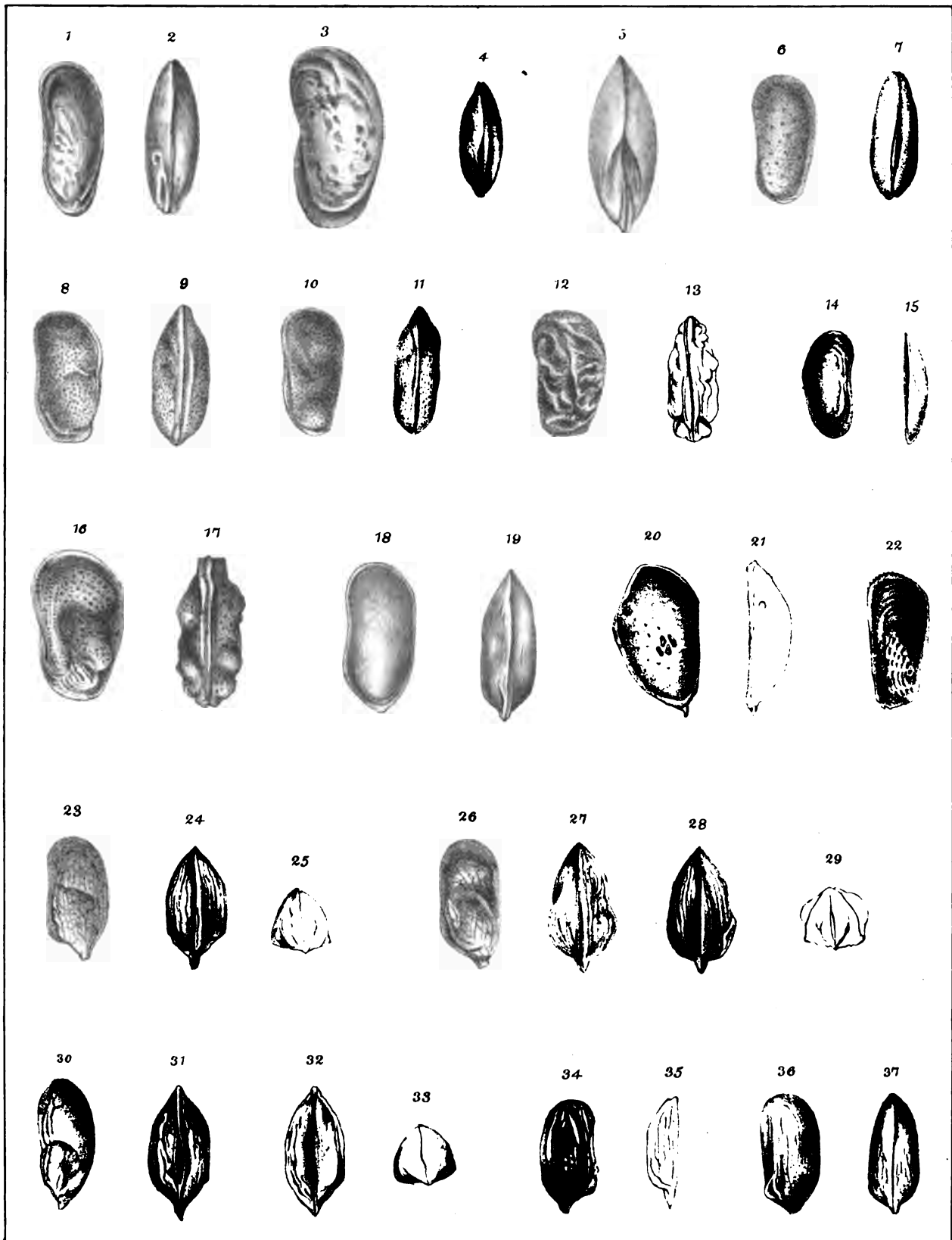
# PLATE XIII.

FIG.

|     |                                      |  |   |                               |
|-----|--------------------------------------|--|---|-------------------------------|
| 1.  | <i>Cythere Macallana</i> .           | Carapace, seen from left side.             | } | × 60 (Kilchattan.)            |
| 2.  | — —                                  | " " above.                                 |   |                               |
| 3.  | <i>Cythere porcellanea</i> .         | Carapace, seen from left side.             | } | × 60 (West Tarbert.)          |
| 4.  | — —                                  | " " above.                                 |   |                               |
| 5.  | — —                                  | " " below.                                 |   |                               |
| 6.  | <i>Cythere tenera</i> .              | Carapace, seen from left side.             | } | × 60<br>(Cardiff New Dock.)   |
| 7.  | — —                                  | " " above.                                 |   |                               |
| 8.  | <i>Cythere castanea</i> .            | Carapace (of female), seen from left side. | } | × 40<br>(Cardiff New Dock.)   |
| 9.  | — —                                  | " " " above.                               |   |                               |
| 10. | — —                                  | " (of male), " left side.                  |   |                               |
| 11. | — —                                  | " " " above.                               |   |                               |
| 12. | <i>Cythere crispata</i> .            | Carapace, seen from left side.             | } | × 60<br>(West Tarbert, silt.) |
| 13. | — —                                  | " " above.                                 |   |                               |
| 14. | <i>Cythere deflexa</i> .             | Right valve, seen from side.               | } | × 40 (Jordan Hill.)           |
| 15. | — —                                  | " " above.                                 |   |                               |
| 16. | <i>Cythere Cluthæ</i> .              | Carapace, seen from left side.             | } | × 84 (Kilchattan.)            |
| 17. | — —                                  | " " above.                                 |   |                               |
| 18. | <i>Cytherura Sarsii</i> .            | Carapace, seen from left side.             | } | × 60<br>(Kames Bay, Cumbræ.)  |
| 19. | — —                                  | " " above.                                 |   |                               |
| 20. | <i>Bairdia</i> (?) <i>Cambrica</i> . | Right valve, seen from side.               | } | × 84<br>(Cardiff New Dock.)   |
| 21. | — —                                  | " " above.                                 |   |                               |
| 22. | <i>Cythere quadridentata</i> .       | Carapace, seen from left side.             |   | × 40 (Loch Gilp.)             |
| 23. | <i>Cytherura cornuta</i> .           | Carapace (of female), seen from left side. | } | × 40<br>(West Tarbert, silt.) |
| 24. | — —                                  | " " below.                                 |   |                               |
| 25. | — —                                  | " " front.                                 |   |                               |
| 26. | <i>Cytherura gibba</i> .             | Carapace (of female), seen from left side. | } | × 40<br>(West Tarbert, silt.) |
| 27. | — —                                  | " " above.                                 |   |                               |
| 28. | — —                                  | " " below.                                 |   |                               |
| 29. | — —                                  | " " front.                                 |   |                               |
| 30. | <i>Cytherura producta</i> .          | Carapace, seen from left side.             | } | × 50<br>(Cardiff New Dock.)   |
| 31. | — —                                  | " " above.                                 |   |                               |
| 32. | — —                                  | " " below.                                 |   |                               |
| 33. | — —                                  | " " front.                                 |   |                               |
| 34. | <i>Cytherura quadrata</i> .          | Right valve, seen from side.               | } | × 40 (Belfast.)               |
| 35. | — —                                  | " " above.                                 |   |                               |
| 36. | <i>Cytherura cuneata</i> .           | Carapace, seen from left side.             | } | × 50<br>(West Tarbert, silt.) |
| 37. | — —                                  | " " above.                                 |   |                               |

(NOTE.—By a mistake of the lithographer fig. 4 has been made of a smaller size than the others.)

Post-Tertiary Entomostraca Pl. XIII.





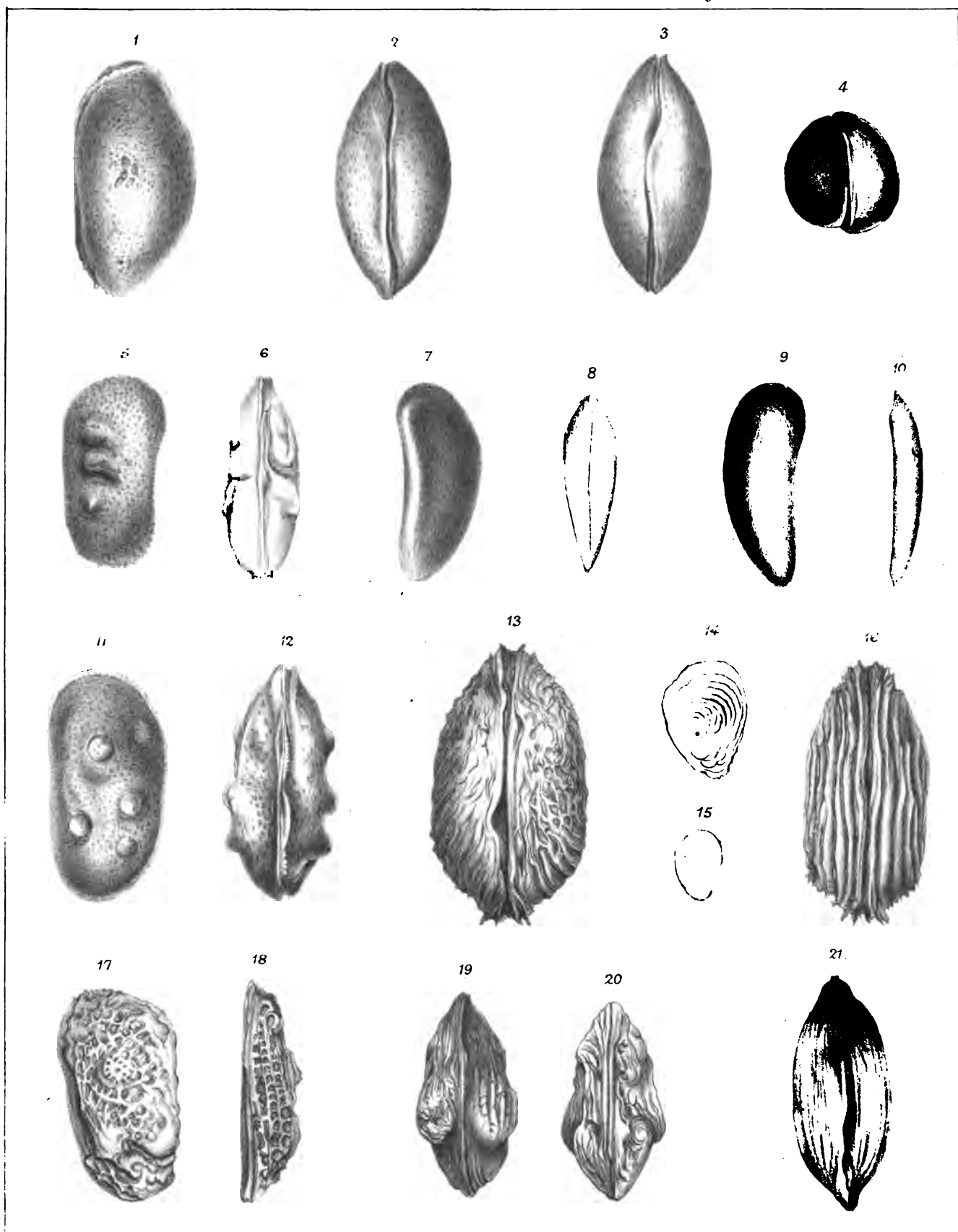




# PLATE XV.

FIG.

- |         |                                |  |                                 |
|---------|--------------------------------|--|---------------------------------|
| 1.      | <i>Bairdia inflata.</i>        | Carapace, seen from left side.           | } × 40<br>(Oban, Raised-beach.) |
| 2.      | — —                            | " " above.                               |                                 |
| 3.      | — —                            | " " below.                               |                                 |
| 4.      | — —                            | " " front.                               |                                 |
| 5.      | <i>Cypris gibba.</i>           | Carapace, seen from right side.          | } × 40 (Hornsea.)               |
| 6.      | — —                            | " " above.                               |                                 |
| 7.      | <i>Pontocypris mytiloides.</i> | Carapace, seen from left side.           | } × 40<br>(Oban, Raised-beach.) |
| 8.      | — —                            | " " above.                               |                                 |
| 9.      | <i>Paracypris polita.</i>      | Right valve, seen from outside.          | } × 40<br>(Oban, Raised-beach.) |
| 10.     | — —                            | " " above.                               |                                 |
| 11.     | <i>Cytheridea torosa.</i>      | Carapace, seen from left side.           | } × 40 (Mundesly, Crag.)        |
| 12.     | — —                            | " " above.                               |                                 |
| 13.     | <i>Cythere mirabilis.</i>      | Carapace of male, seen from above.       | } × 40 (Dryleys.)               |
| 14, 15. | — —                            | Outlines of the young shell.             |                                 |
| 16.     | — —                            | Carapace of male, seen from below.       |                                 |
| 17.     | <i>Cythere Logani.</i>         | Left valve of female, seen from outside. | } × 40 (Elie.)                  |
| 18.     | — —                            | " " below.                               |                                 |
| 19.     | <i>Cythere globulifera.</i>    | Carapace, seen from below.               | } × 84 (Dryleys.)               |
| 20.     | — —                            | " " above.                               |                                 |
| 21.     | <i>Cytherura concentrica.</i>  | Carapace, seen from below.               | × 84                            |



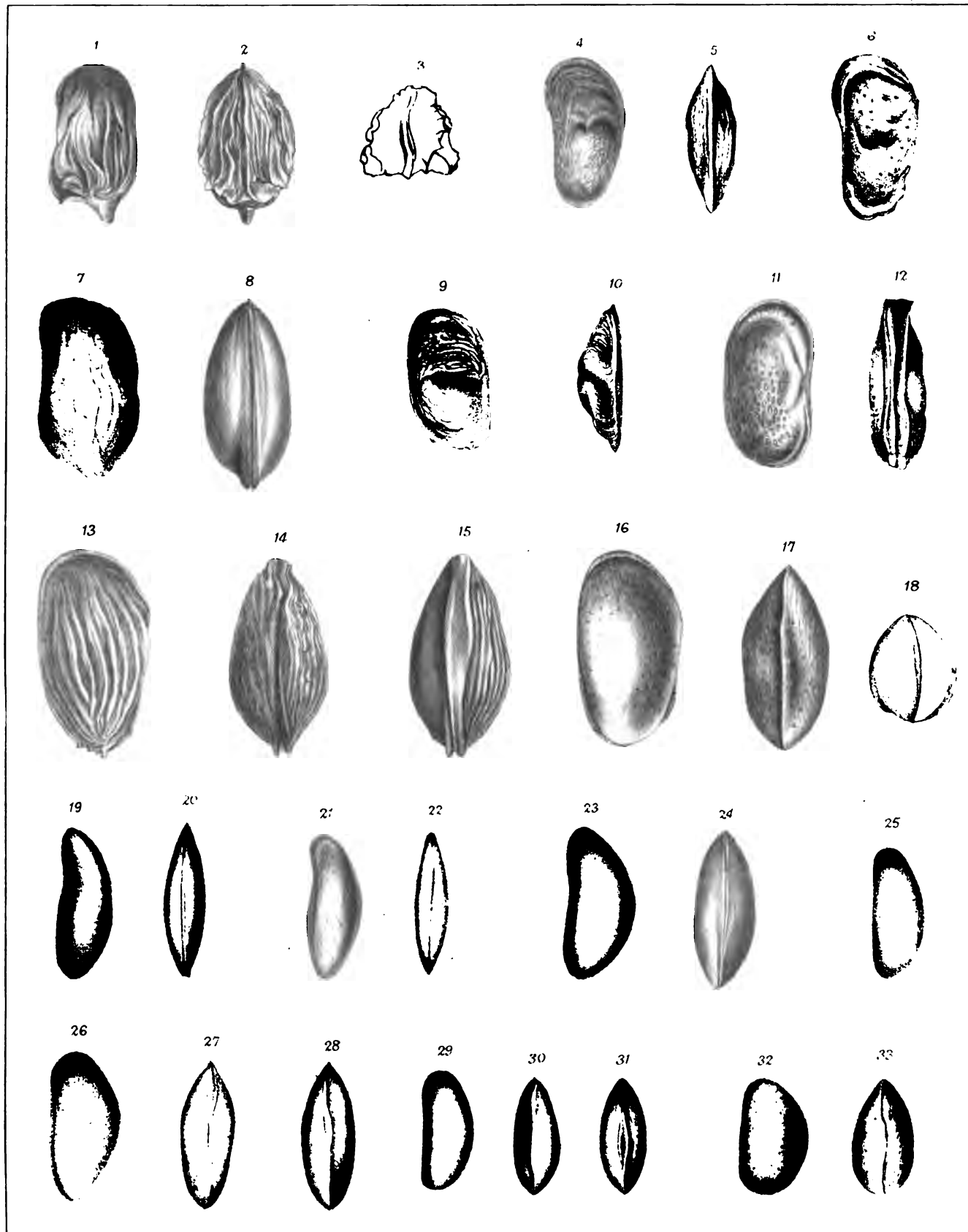




# PLATE XVI.

FIG.

- |     |  |  |  |
|-----|--|--|--|
| 1.  | <i>Cytherura acuticostata</i> .          | Carapace, seen from left side.             | } $\times 60$<br>(Oban, Raised-beach.)   |
| 2.  | — —                                      | " " below.                                 |  |
| 3.  | — —                                      | " " behind.                                |  |
| 4.  | <i>Limnocythere antiqua</i> .            | Carapace, seen from left side.             | } $\times 60$<br>(Crofthead and Dipple.) |
| 5.  | — —                                      | " " above.                                 |  |
| 6.  | <i>Cythere latimarginata</i> .           | Left valve (imperfect), seen from outside. | } $\times 60$ (Hopton Cliff.)            |
| 7.  | <i>Cytherura flavescens</i> .            | Carapace, seen from left side.             |  |
| 8.  | — —                                      | " " above.                                 | } $\times 84$ (Colintraive.)             |
| 9.  | <i>Bythocythere constricta</i> .         | Left valve, seen from outside.             |  |
| 10. | — —                                      | " " above.                                 | } $\times 40$ (Helensburgh.)             |
| 11. | <i>Cythere</i> (?) <i>semipunctata</i> . | Carapace, seen from right side.            |  |
| 12. | — —                                      | " " below.                                 | } $\times 60$<br>(Oban, Raised-beach.)   |
| 13. | <i>Cythere costellata</i> .              | Carapace, seen from left side.             |  |
| 14. | — —                                      | " " above.                                 | } $\times 60$<br>(Selsey, Pholas-bed.)   |
| 15. | — —                                      | " " below.                                 |  |
| 16. | <i>Cythere gibbosa</i> .                 | Carapace, seen from left side.             | } $\times 84$ (Portrush.)                |
| 17. | — —                                      | " " below.                                 |  |
| 18. | — —                                      | " " front.                                 |  |
| 19. | <i>Paradoxostoma flexuosum</i> .         | Carapace, seen from left side.             | } $\times 60$ (Cardiff Dock.)            |
| 20. | — —                                      | " " above.                                 |  |
| 21. | <i>Paradoxostoma tenerum</i> .           | Carapace, seen from left side.             | } $\times 40$ (Dumbarton.)               |
| 22. | — —                                      | " " above.                                 |  |
| 23. | <i>Paradoxostoma Fischeri</i> .          | Carapace, seen from left side.             | } $\times 60$<br>(West Tarbert, silt.)   |
| 24. | — —                                      | " " above.                                 |  |
| 25. | <i>Paradoxostoma arcuatum</i> .          | Carapace, seen from left side.             | $\times 40$ (Oban, Raised-beach.)        |
| 26. | <i>Pontocypris trigonella</i> .          | Carapace, seen from left side.             | } $\times 40$ (Duntroon.)                |
| 27. | — —                                      | " " above.                                 |  |
| 28. | — —                                      | " " below.                                 |  |
| 29. | <i>Argillæcia cylindrica</i> .           | Carapace, seen from left side.             | } $\times 40$ (Duntroon.)                |
| 30. | — —                                      | " " above.                                 |  |
| 31. | — —                                      | " " below.                                 |  |
| 32. | <i>Xestoleberis aurantia</i> .           | Carapace of female, seen from left side.   | } $\times 40$ (Belfast.)                 |
| 33. | — —                                      | " " above.                                 |  |





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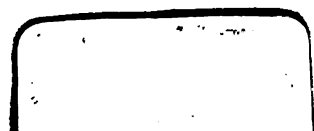
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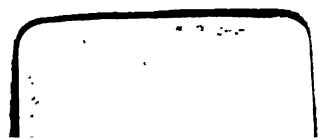
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